PB89-153712

Superfund Record of Decision (EPA Region 8)
California Gulch, Leadville
Lake County, Colorado, March 1988
First Remedial Action

(U.S.) Environmental Protection Agency
Washington, DC

29 Mar 88

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Environmental Protection
Agency

Office of
Emergency and
Remedial Response

EPA/ROD/R08-88/020
March 1988

PB89-153712

EPA

Superfund Record of Decision:

California Gulch, CO

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16. Abstract (Limit: 200 words)

The California Gulch site is located in Lake County, Colorado, approximately 100 miles southwest of Denver. The study area for this first remedial action encompasses an 11.5 m^2 watershed, which includes the city of Leadville, that drains along California Gulch to the Arkansas River. Between 1859 and 1986, the area was extensively mined for gold, lead, silver, copper, zinc and manganese. Because of these ining operations, the Yak Tunnel was constructed to dewater mines and facilitate ineral exploration and development. Studies indicate that the Yak Tunnel discharges a combined total of 210 tons per year of cadmium, lead, copper, manganese, iron, and zinc into California Gulch, which drains into the Arkansas River. Both California Gulch and the Arkansas River are used by the public for recreation, and the Arkansas River is heavily used for irrigation, livestock watering, public water supply and fisheries as well. Surface water contamination is the major impact of the Yak Tunnel discharge. Heavy metal migration through surface water has also caused ground water and sediment contamination. Primary contaminants of concern affecting the surface water, sediments, and ground water are cadmium, copper, lead and zinc.

(See Attached Sheet)

17. Document Analysis a. Descriptors
Record of Decision
California Gulch, CO
First Remedial Action
Contaminated Media: gw, sw, sediments
Key Contaminants: cadmium, copper, lead, zinc

b. Identifiers/Open-Ended Terms

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California Gulch, CO
First Remedial Action

16. ABSTRACT (continued)

The selected remedial action for this site includes: construction of surge ponds at the portal of Yak Tunnel to protect the California Gulch site and the Arkansas River from accidental release of acid water, sludge, and sediments; construction of concrete plugs at locations in the tunnel to reduce migration of contaminated water and reduce the extraction of metals from raw mineral ore; sealing shafts and drill holes, diversion of surface water away from tunnel recharge areas, and grouting of highly fractured rock; implementation of a monitoring program to detect leaks, seeps or migration of contaminated ground water; and installation of an interim treatment plant to treat ground water, which will be pumped to control surface seeps and migration of contaminated surface water. The estimated capital cost of the selected remedy is $11,982,770 with annual O&M costs of $460,307.

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DECLARATION FOR THE RECORD OF DECISION

SITE NAME AND LOCATION

California Gulch
Leadville, Lake County, Colorado
Operable Unit I -- Yak Tunnel

STATEMENT OF BASIS AND PURPOSE

This decision document presents the remedial action for Operable Unit I of the California Gulch site selected by the United States Environmental Protection Agency (EPA) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the National Contingency Plan (NCP).

This decision is based upon the administrative record for the Yak Tunnel operable unit of the California Gulch site. The attached index identifies the items which comprise the administrative record upon which the selection of the remedial action was based.

The State of Colorado has reviewed the selected remedy.

DESCRIPTION OF THE SELECTED REMEDY

Operable Unit I addresses the discharge of acid mine drainage containing high levels of metals from the Yak Tunnel into California Gulch. The hazardous substances of primary concern are cadmium, copper, lead, and zinc. The Yak Tunnel discharge contributes to contamination of California Gulch, the Arkansas River, and the associated shallow alluvial ground water and sediment systems.

The selected remedy for this operable unit of the California Gulch site is designed to minimize the flow of water out of the Yak Tunnel and to prevent the uncontrolled release of tunnel effluent to the environment. The remedy is comprised of the following elements.

1.C

1. Measures to minimize the impact of surges from the tunnel on California Gulch and the Arkansas River.

Surge ponds will be constructed at the portal of the Yak Tunnel to protect California Gulch and the Arkansas River from accidental releases of acidic water, sludges, or sediments from the tunnel due to tunnel inspections or construction. Surge ponds will be constructed prior to the installation of the tunnel plugs. Once the plugs are in place, the surge ponds will be incorporated into the interim water treatment system described below.

2. Construction of concrete plugs at three locations within the tunnel to flood the sulfide zones, to halt the uncontrolled discharge of tunnel effluent to California Gulch, and to prevent surges.

Plugs will be located in competent rock near the tunnel portal, in the Ibex-Irene area near the middle of the tunnel, and below the Resurrection Mine workings near the head of the tunnel. The plugs will serve two primary functions: source control and management of migration. Water will rise and flood the void space behind each of the plugs. To the extent that sulfide mineral zones exist in these areas, they will be totally or partially inundated. Such inundation will prevent or reduce the chemical reactions which release metals from the minerals, thereby reducing the contamination of water within the mineralized zones. In addition, the plugs will minimize the migration of contaminated water to California Gulch. The plugs, especially the lowermost one, will serve to prevent surges of water, sludges, and sediments from the portal of the tunnel.

3. Measures to minimize the inflow of surface water and ground water into the Yak Tunnel System.

These measures include sealing shafts and drill holes, diverting surface water away from tunnel recharge areas, and grouting areas of highly fractured rock. This combination of measures will reduce the amount of water entering the Yak Tunnel system and will thereby decrease the cost and enhance the effectiveness of the related response actions.

4. Implementation of a monitoring program to detect any leakage, seeps, or migration of contaminated ground water.

Evaluation and modeling of all available geological and hydrological information indicates that rising water levels in the mine voids behind the plugs may result in surface seeps, particularly in the area behind the portal plug. Also, there is the potential for contaminated ground water to migrate towards areas where it may have a negative impact, such as Evans Gulch or the vicinity of the Leadville Drainage Tunnel. For these

i.d

reasons, a monitoring network will be constructed prior to the installation of the tunnel plugs.

The monitoring program will consist of both field inspection and a surface and ground water monitoring network. Periodic field inspections will be needed to identify any surface seepage, particularly in the vicinity of the portal plug. The ground water monitoring network will consist of a series of monitoring wells and/or shafts to measure water levels and water quality. The number and location of monitoring points associated with each plug will depend on the geologic and hydrologic conditions associated with each. The monitoring points will be used to identify baseline information on ground water levels and quality, against which changes in water levels and quality can be measured. The surface water monitoring network will be used to monitor changes in both quality or flow as a result of the remedy. Surface monitoring stations will be in California Gulch and Evans Gulch. Both the field inspections and the periodic water measurements will be used to predict, identify, and track any surface water seeps or changes in ground water flow and quality.

5. Measures to prevent uncontrolled migration of contaminated water.

Because rising water levels pose a risk of seepage and migration of contaminated water, the selected remedy incorporates measures to mitigate this risk. Grouting of potential leakage points, such as fracture zones, caved-in areas, and drill holes, will be done. To control ground water levels, and thereby control surface seeps and migration of contaminated water, a system to lower water levels will be installed behind the portal plug. As necessary, water will be pumped from behind the portal plug and routed to an interim treatment plant near the portal of the tunnel. The plant will use available technologies to settle out metals and then release the water to California Gulch. The surge ponds described above will become part of this treatment system. Sludge will be retained in the ponds while the interim treatment system is operating. As part of a subsequent operable unit, a comprehensive treatment system will be developed and integrated into a permanent site remedy.

The selected remedy also includes contingency plans for the Ibex-Irene and Resurrection plugs. Because the probability of surface seepage caused by these plugs is small, at the outset only monitoring is necessary. If, however, monitoring indicates that adverse impacts may occur, a pump and treat system, similar to the one installed for the portal plug, will be installed and operated.

i.e

6. Operations and maintenance of the selected remedy.

Routine operations and maintenance of the installed facilities will be required. This includes the surge ponds, the water control measures, the monitoring systems, and the water collection and interim treatment plant.

These elements comprise the first remedial operable unit at the California Gulch site. Subsequent operable units will address public health and environmental impacts from mine tailings and wastes, surface water in California Gulch, the ephemeral tributaries to California Gulch, and the Arkansas River, soils, slag, sediments, air, ground water, and biological media.

DECLARATIONS

Pursuant to CERCLA, as amended by SARA, and the NCP, I have determined that the selected remedy for Operable Unit I at the California Gulch site is protective of human health and the environment, attains all location-specific and action-specific Federal and State requirements that are applicable or relevant and appropriate (ARARs) to this remedial action, and is cost-effective.

The remedy is not expected to attain all the chemical-specific requirements. Because of the contribution of other sources to surface water contamination, the remedy is not expected to attain the degree of cleanup of surface water set by these chemical-specific requirements. Therefore, I have found that a waiver is necessary under Section 121(d)(4)(A) of SARA. A waiver is appropriate if the remedial action selected is only part of a total remedial action that will attain a level or standard of control at least equivalent to the legally applicable or relevant and appropriate standard, requirement, criteria, or limitation. The treatment facility component of the selected remedy is an interim action designed to decrease the release and threatened release of metals from the Yak Tunnel. It is only a first step toward cleanup of California Gulch surface water and is part of a total remedial action for the site. Response actions in subsequent operable units, in combination with this selected remedy, will attain a level or standard of control at least equivalent to ARARs.

The remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable.

i.f

Because this remedy will result in hazardous substances remaining on site above health-based levels, reviews of the remedial action will be conducted no less often than each 5 years after the initiation of the remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

March 29, 1988
Date

James J. Scherer
Regional Administrator
Region VIII, U.S. Environmental
Protection Agency

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I. SITE NAME, LOCATION, AND DESCRIPTION

The California Gulch site is in Lake County, Colorado, approximately 100 miles southwest of Denver (Figure 1). The Phase I Remedial Investigation (RI) study area, which includes the City of Leadville (population 3,800), encompasses an 11.5-square-mile watershed that drains along California Gulch to the Arkansas River west of Leadville. The California Gulch drainage basin ranges from 10,000 to 14,000 feet above mean sea level (msl) in elevation (EPA, 1987a).

The RI conducted by the U.S. Environmental Protection Agency (EPA) indicates that the area is contaminated with metals including cadmium, copper, lead, and zinc emanating from numerous abandoned and some active mining and minerals processing facilities. A primary source of the metals contamination is acid mine drainage from the Yak Tunnel into California Gulch.

The Yak Tunnel (Figure 2) extends underground approximately 3-1/2 to 4 miles into Iron Hill and Breece Hill. The tunnel collects ground water from numerous underground mines and then discharges flow into California Gulch.

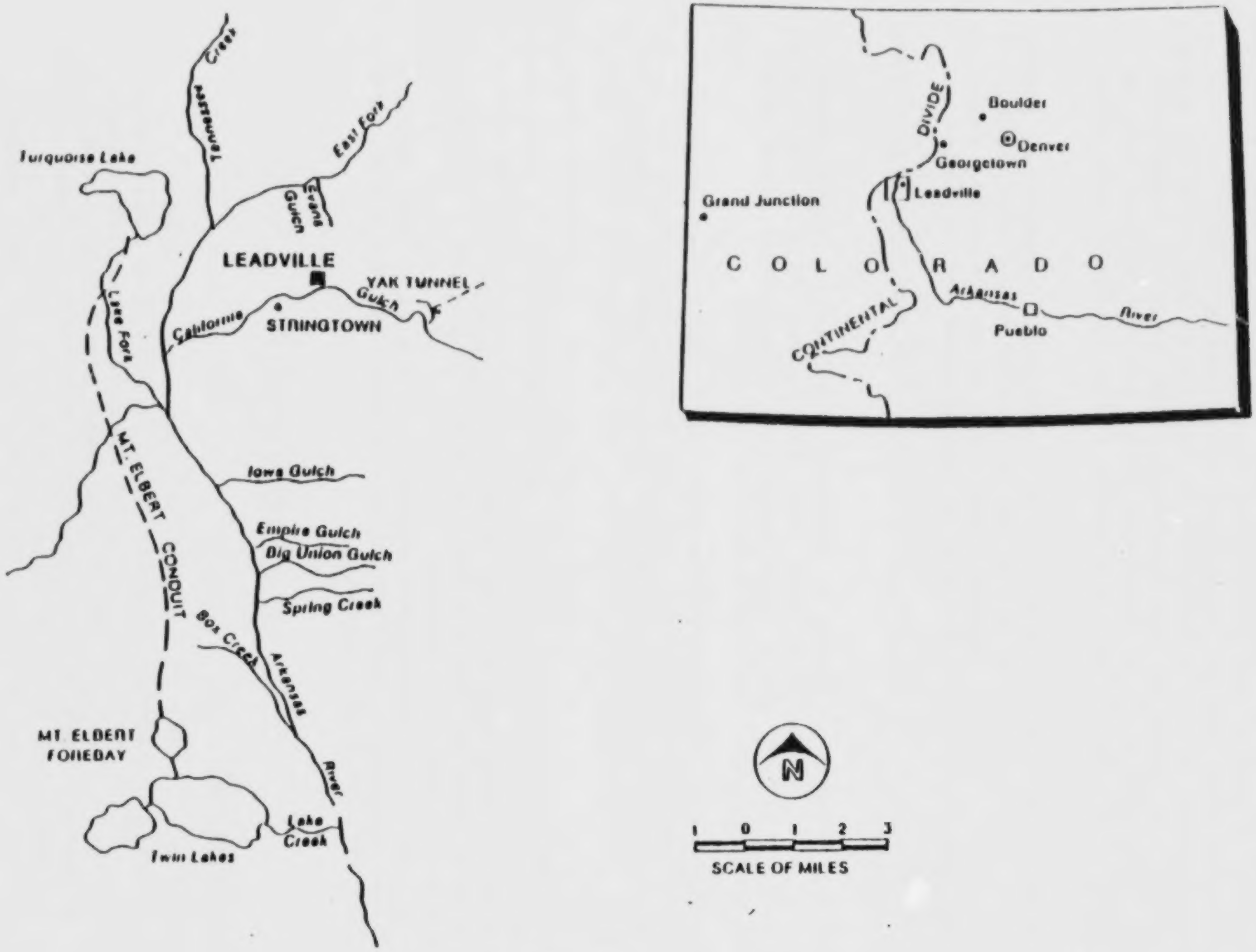
Based on the annual average flow rate and annual average dissolved concentrations, the Yak Tunnel discharges a combined total of 210 tons per year of cadmium, copper, iron, lead, manganese, and zinc into California Gulch (EPA, 1987a).

This Record of Decision (ROD) addresses the Yak Tunnel as an "operable unit" of the California Gulch site. Under the National Contingency Plan (NCP), an operable unit is "a discrete part of the entire response action that decreases a release, threat of release, or pathway of exposure" (40 CFR § 300.68[c]). Subsequent operable units will address mine wastes, ephemeral surface water, ground water, soils, and other environmental media.

II. SITE STATUS

SITE HISTORY

Mining activities in Leadville began in 1859 when gold-bearing placer deposits were found along California Gulch. Since that time, mining activity has almost been continuous, although there have been production cessations or slowdowns because of economic conditions or labor issues. An estimated 26 million tons of ore were produced in the Leadville Mining District from 1859 through 1986 (ASARCO, 1987).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Tennessee Creek
East Fork
Evans Gulch
LEADVILLE
YAK TUNNEL
Gulch
California
STRINGTOWN
Lake Fork
MT. ELBERT CONDUIT
Iowa Gulch
Empire Gulch
Big Union Gulch
Spring Creek
Box Creek
Arkansas
River
MT. ELBERT FOREBAY
Twin Lakes
Lake Creek
Boulder
Denver
DIVIDE
Georgetown
Leadville
Grand Junction
C O L O R A D O
CONTINENTAL
Arkansas
Pueblo
River
N
1 0 1 2 3
SCALE OF MILES

FIGURE 1

LOCATION MAP

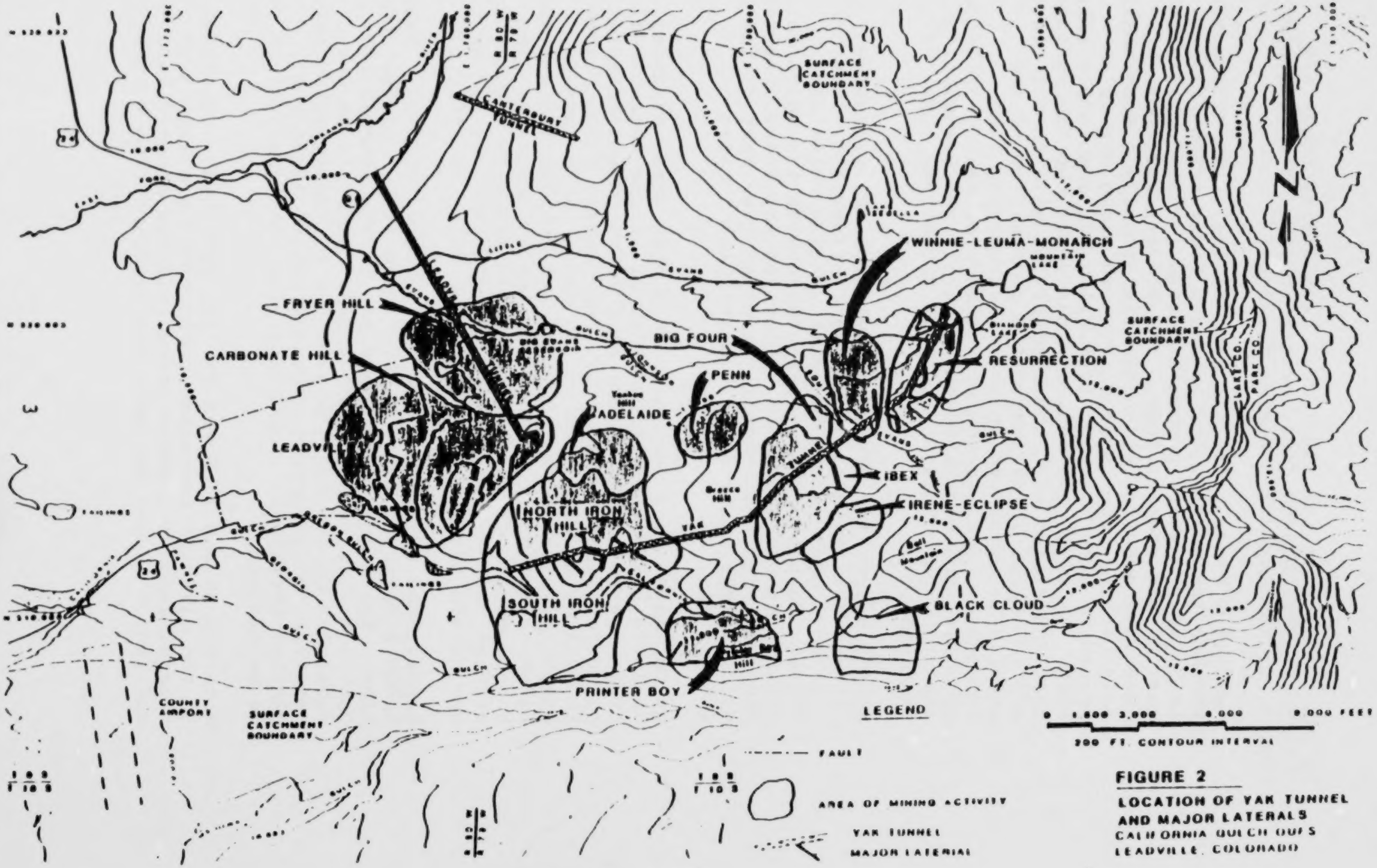
CANTERBURY TUNNEL
SURFACE CATCHMENT BOUNDARY
WINNIE-LEUMA-MONARCH
FRYER HILL
CARBONATE HILL
BIG FOUR
PENN
RESURRECTION
ADELAIDE
LEADVI
NORTH IRON HILL
IBEX
IRENE-ECLIPSE
YAK
TUNNEL
SOUTH IRON HILL
BLACK CLOUD
PRINTER BOY
COUNTY AIRPORT
SURFACE CATCHMENT BOUNDARY
SURFACE CATCHMENT BOUNDARY
LAKE CO.
PARK CO.
N
LEGEND
FAULT
AREA OF MINING ACTIVITY
YAK TUNNEL
MAJOR LATERAL
0 1,500 3,000 6,000 9,000 FEET
200 FT. CONTOUR INTERVAL

FIGURE 2

LOCATION OF YAK TUNNEL
AND MAJOR LATERALS
CALIFORNIA GULCH OU'S
LEADVILLE, COLORADO

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In its comments on the Yak Tunnel Feasibility Study (FS) (ASARCO, 1987), ASARCO Incorporated provided the following history of the Leadville Mining District:

> Leadville began as a gold camp in 1861 when prospectors working the channels of Arkansas River tributaries found gold-bearing placer deposits in California Gulch, east of the present town. The placers were not extensive and production declined rapidly. Some small gold-bearing lode veins discovered along the gulch helped to keep the camp from dying out completely after 1868. In 1874, two men, curious about the "heavy sand" that interfered with the recovery of gold in the placer sluice boxes, investigated the composition of the material. It proved to be silver-bearing lead carbonate. Examination of outcrops on nearby hillsides disclosed the source of the mineral, and Leadville's importance as a mining district dates from this discovery.
>
> As the search for ore became widespread, extensive replacement deposits of lead and silver and, later on, rich gold ores associated with fissure veins were found. Copper, usually associated with the gold ore, assumed minor importance. Zinc and manganese minerals occurred with the lead-silver ores; they were of little value in the early days, but were later mined extensively.
>
> As the mines were deepened and mining areas expanded, drainage became an economic factor in the operational costs, particularly during periods of depressed metal prices or labor unrest. The Yak Tunnel, which started in 1895 as an extension of the Silver Cord Tunnel, eventually reached a length of 3-1/2 miles and was the first of two major efforts to improve drainage. The second major effort, the Leadville Drainage Tunnel, was started in 1943 and was finally completed as far as the new Mikado shaft near Stray Horse Gulch in 1952.....
>
> Depressions occurred in 1893, 1907, and 1930-34. Labor trouble occurred in 1896, 1897, and 1919. During these times, the majority of the mines in the Leadville District were closed and flooded. Mining also was curtailed by low metal prices and by depletion of ore reserves, which were not maintained in advance of mining; therefore, economic production levels could not be maintained.
>
> With the advent of World War II, operating properties in the district increased production as a result of the federal support-premium price paid for copper, lead, and zinc. During the war, the major portion of the

> recorded production came from processing old dumps by the Ore and Chemical Company and John Hamm Milling Company; however, production increases were recorded from the Resurrection No. 2, Fortune, Eclipse, and Hellena shafts, as well. Ore output practically ceased after 1957 when the Irene shaft was closed due to low metal prices.
>
> In 1965, a joint venture between ASARCO Incorporated and Resurrection Mining Company reopened the Irene workings and substantial ore reserves were proven in the down-dropped block in the eastern portion of the Leadville district bordered by the Ball Mountain, Weston, and Garbutt faults. In 1969, a new shaft, the Black Cloud, was sunk in Iowa Gulch to access the newly found ore reserves. The Black Cloud mine and mill went into production in April 1971 and has operated continuously since that time. The other significant mine to operate in the district since the Resurrection Mill shut down in 1957, is the Sherman Mine at the head of Iowa Gulch. This mine, now owned by the Leadville Corporation, was operated by Day Mines and the Hecla Mining Company between 1976 and 1984, after which it was shut down for economic reasons.

There are currently a few active, moderate-sized mining and reprocessing operations in the Leadville area. However, since mining activities began in Leadville, hundreds of mines, numerous mills, more than 40 smelters, and several placer operations have contributed to both the past economy and current environmental conditions in Leadville.

Emmons et al. (1927) identified 1,329 mine shafts, 155 tunnels, and 1,628 prospect holes in the Leadville Mining District, which have an estimated aggregate length of 75 miles. In the surrounding area, Behre (1953) identified an additional 1,800 openings of various types. These workings comprise an extensive network of connected tunnels and shafts.

The Yak Tunnel was constructed to dewater mines and to facilitate mineral exploration and development. The tunnel, driven in 1895 to drain the Iron Hill mines, was extended several times. The last extension was in 1923.

The tunnel now has several major laterals and drifts that extend from the tunnel into the various mine workings. ASARCO (1987) reports some of the connections off the tunnel as follows: the Horseshoe, the Rubie, the North Mike, the South Mike, the Ibex No. 4, the Little Winnie, the Resurrection No. 1, the Fortune, the Resurrection No. 2, and the Dolly B. In addition, there are six working winzes: the White Cap, the Cord, the Mike, the Willard, the My Day, and the Diamond. EPA estimated that 60,000 feet of tunnels and major laterals and 55 to 74 million cubic feet of void space are associated with the tunnel mining activities (EPA, 1987b).

The current physical condition of the Yak Tunnel is unknown but is suspected to be poor. The last inspection, conducted by ASARCO in 1983, disclosed that the tunnel roof was generally weak and had caved in at many places.

RESPONSE HISTORY

In 1982 and 1983, EPA conducted a preliminary evaluation of the California Gulch site, which consisted of an assessment of existing data and a site inspection. In 1983, the California Gulch site was placed on the National Priorities List of sites which are the highest priority for EPA response action.

EPA began the RI of the site in 1984. The Phase I RI report, which primarily addresses surface and ground water contamination, was released in May 1987. During the RI, EPA determined that response actions for the site could be separated into operable units to facilitate site remediation. EPA conducted a removal operable unit to connect a household to the public water system. EPA also developed a remedial operable unit to decrease the release and threatened release of hazardous substances, pollutants, and contaminants from the Yak Tunnel.

In June 1987, EPA released a FS report and, in August, a proposed remedial action plan for the Yak Tunnel operable unit. EPA held a 90-day public comment period and a public meeting to provide opportunity for public review and comment on the FS report and proposed remedial action plan.

This ROD sets forth the remedy selected for the first remedial operable unit at the California Gulch site. The primary purpose of this remedy is to decrease the discharge of contaminated water from the Yak Tunnel. Subsequent operable unit studies are planned to address mine wastes and ephemeral surface flow, and overall site conditions including soils, slag, sediments, air quality, surface water, and ground water.

ENFORCEMENT HISTORY

In 1982 and 1983, EPA identified seven parties as potentially responsible for California Gulch site contamination based on their ownership or operation of mining or minerals processing facilities at the site.

In the spring and summer of 1983, EPA sent notice letters to Apache Energy and Minerals Company, ASARCO, C and H Development Corporation, Hecla Mining Company, Robert Elder, Resurrection Mining Company, and Rock Hill Mines Company. In the letters, EPA notified the parties that they were considered potentially responsible for the release of hazardous substances, pollutants, and contaminants at the site, and offered each party an opportunity to participate voluntarily in a response action. EPA enclosed with each letter a copy of a draft work plan for the RI/FS. None of the potentially responsible parties agreed to prepare the RI/FS or undertake response actions at the site. Therefore, EPA performed the Phase I RI and the Yak Tunnel FS using Superfund money.

In spring 1986, EPA identified and sent notice letters to six additional potentially responsible parties: Atlas Mortgage Company; Denver and Rio Grande Western Railroad Company; Leadville Corporation; Leadville Silver and Gold, Inc.; Newmont Mining Corporation; and the Res-ASARCO Joint Venture. Again, these parties were identified based on their ownership and operation of mining and minerals processing facilities at the site.

In August 1986, the United States filed an action against these 13 parties in the United States District Court for the District of Colorado: United States v. Apache Energy and Minerals Co., No. 86-C-1675 (D. Colo. filed Aug. 6, 1986). In this action, the United States seeks to obtain a cleanup for the site and recovery of past and future response costs. In February of 1987, this case was consolidated with a related State case titled Colorado v. ASARCO, Inc., No. 83-C-2388 (D. Colo. filed Dec. 9, 1983).

The United States will seek to have responsible parties implement the Yak Tunnel remedy. Two of the defendants have proposed to conduct remedies for the tunnel. These remedies, which were evaluated by EPA during the remedy selection process, are discussed in the "Alternatives Evaluation" section of this ROD.

III. SITE CHARACTERISTICS

This section summarizes the nature and extent of the release and pathways of exposure to hazardous substances, pollutants, and contaminants discharged from the Yak Tunnel.

SOURCE OF CONTAMINATION

The Yak Tunnel and its laterals extend through sulfide and carbonate ore bodies under Iron Hill, Breece Hill, upper California Gulch, and upper Evans Gulch as shown previously

(Figure 2). The suite of minerals that constitutes the ore bodies drained by the Yak Tunnel is a complex assemblage including native copper, gold, and silver; and sulfides, carbonates, and silicates of these and other metals (EPA, 1987b) The primary minerals are predominately sulfides of iron, lead, and zinc. As discussed in the "Site History" subsection of this ROD, these ore bodies have been extensively mined.

This mining activity has exposed mineralized ore deposits to water and oxygen. Ground water in this area is derived primarily from precipitation and snowmelt. Water percolates into the ground and moves through the alluvium and bedrock in cracks, fissures, faults, and mine workings. As oxygenated ground water flows through the sulfide minerals, it oxidizes the pyrite minerals to form sulfuric acid. The acid dissolves and mobilizes cadmium, copper, iron, lead, manganese, zinc, and other metals and sulfates. The tunnel and its laterals collect this metal-laden acidic water and drain it to the tunnel portal.

Discharge from the Yak Tunnel is continuous with flow ranging from 1 to 3 cubic feet per second (cfs). The highest flows are during spring runoff when the tunnel discharge contains the highest metals concentrations resulting in the poorest water quality. Sampling of Yak Tunnel discharge at the tunnel portal through five quarterly sampling rounds during the Phase I RI indicated the presence of hazardous substances (metals) in the following ranges of concentrations in parts per billion:

Hazardous Substance	Range (ppb)	Arithmetic Mean (ppb)
Cadmium	195-520	209
Copper	731-5,730	2,032
Lead	9-117	42
Zinc	50,100-101,000	68,232

The arithmetic mean of the five sampling periods indicates an average flow of 1.47 cfs. At this average flow rate, the Yak Tunnel discharges 604 pounds of cadmium, 5,874 pounds of copper, 121 pounds of lead, and 197,253 pounds of zinc into the environment every year.

In addition to this continuous discharge of hazardous substances, the Yak Tunnel is subject to "surges" or sudden releases of large quantities of water and sludge (EPA, 1987a). Due primarily to lack of maintenance, the tunnel is deteriorating, and there are cave-ins and blockages in the tunnel or the laterals. The tunnel flow can become dammed or trapped behind the blockages. Water then builds up behind the blockage and eventually breaks through, scouring the buildup of metal-laden sludge from the tunnel floor. Water and sludge are then discharged through the tunnel portal. A surge occurred in 1985 that lasted approximately 24 hours and released an estimated 1 million gallons of contaminated water at an instantaneous peak flow rate of 10 cfs measured at the portal (EPA, 1987a).

PATHWAYS OF MIGRATION

After passing through the tunnel portal, metals from the Yak Tunnel can move through various environmental media. Figure 3 shows a conceptual model of the potentially contaminated media and the pathways of contaminant migration at the site.

Movement of metals through surface water in California Gulch is a major pathway of migration. In turn, the surface water is in active interchange with the shallow ground water system along California Gulch (EPA, 1987a). Both surface water and, to a much lesser extent, ground water discharge to the Arkansas River surface water. Metals precipitate in the surface water system and become a part of the sediments in California Gulch and the Arkansas River. Contaminated sediments may be scoured continuously during high flows and move down California Gulch and the Arkansas River. If exposed to air, contaminated sediments in the stream bed or along the banks may become wind-borne and dispersed through an air pathway.

Surface water contamination is the major impact of the Yak Tunnel discharge. Table 1 compares metals concentrations in the Yak Tunnel effluent with EPA's ambient water quality criteria for acute and chronic toxicity to freshwater aquatic life (EPA, 1987a).*

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*In developing the ambient water quality criteria, EPA determined that the acid soluble test method would be the appropriate method for certain metals. Since there currently is no EPA-approved acid soluble test method, EPA recommends applying the ambient water quality criteria using the "total" recoverable method (see EPA, Quality Criteria for Water 1986, May 1986). During the Phase I RI, EPA used both the dissolved and total metals methods to analyze metals concentrations in surface water (see Phase I RI Report Appendices). In this ROD, all water quality data are reported as total metals. The total metals method best represents the potential toxicity in the surface water chemistry of California Gulch. The use of total metals concentrations may be overly protective in the Arkansas River because of the different chemical environment.

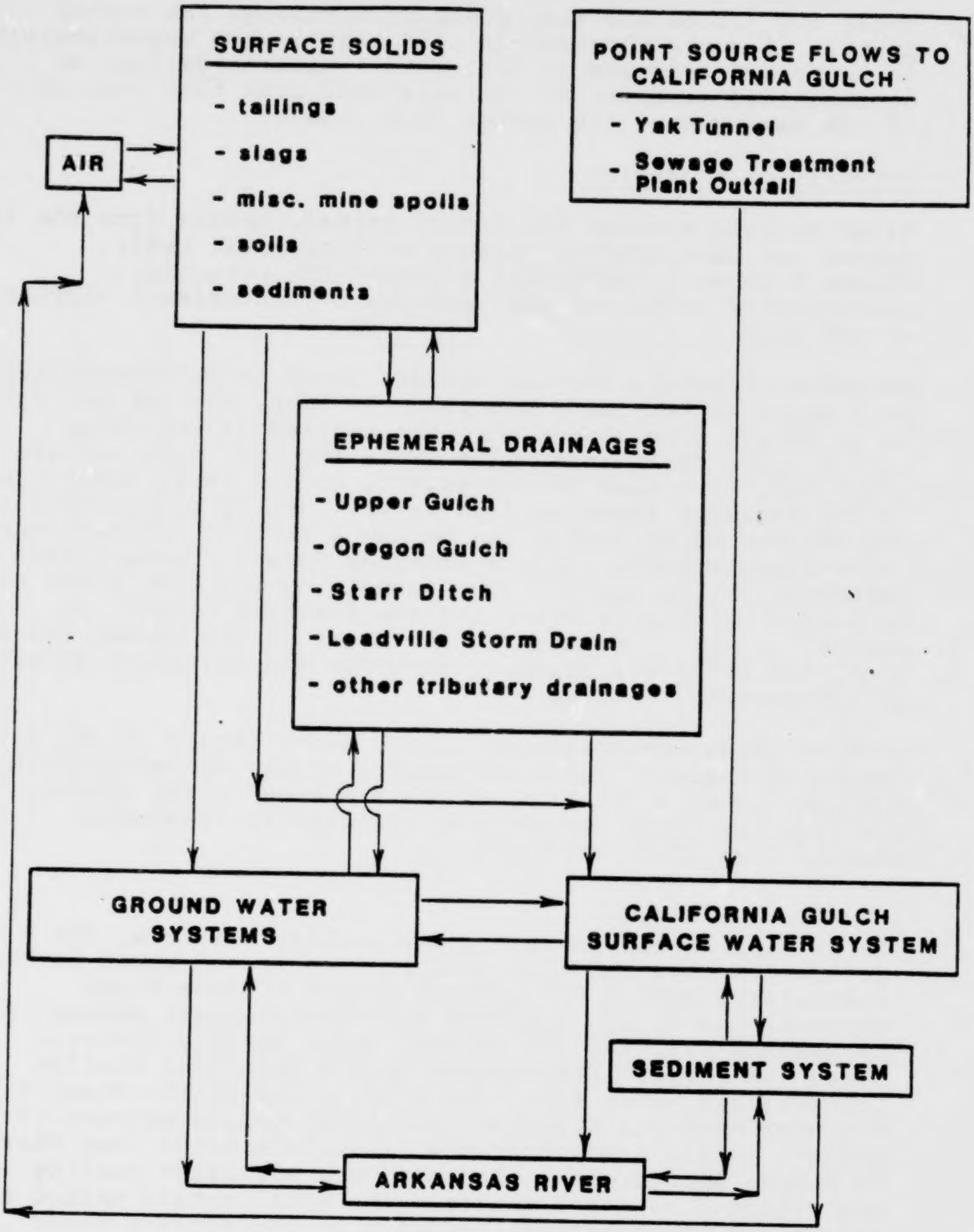
SURFACE SOLIDS
- tailings
- slags
- misc. mine spoils
- soils
- sediments
AIR
POINT SOURCE FLOWS TO CALIFORNIA GULCH
- Yak Tunnel
- Sewage Treatment Plant Outfall
EPHEMERAL DRAINAGES
- Upper Gulch
- Oregon Gulch
- Starr Ditch
- Leadville Storm Drain
- other tributary drainages
GROUND WATER SYSTEMS
CALIFORNIA GULCH SURFACE WATER SYSTEM
SEDIMENT SYSTEM
ARKANSAS RIVER

FIGURE 3

POTENTIALLY CONTAMINATED MEDIA AND PATHWAYS

Table 1
COMPARISON OF METALS CONCENTRATIONS IN YAK TUNNEL DISCHARGE TO AMBIENT WATER QUALITY CRITERIA

Metal	Concentrations (ppb) Ambient Water Quality Criteria[a,b] Acute	 Chronic	 Range Detected in the Yak Tunnel Effluent
Cadmium	3.9	1.1	195-520
Copper	18	12	731-5,730
Lead	82	3.2	9-117
Zinc	120	110	50,100-101,000

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[a] See Appendix C of this ROD for detailed discussion of Ambient Water Quality Criteria.
[b] Values assume hardness of 100 mg/l $CaCO_3$.

Source: EPA, 1987a.

Table 1 shows that the Yak Tunnel discharge would be acutely toxic to freshwater aquatic life, based on both high and low metal concentrations during the five quarterly sampling periods of the Phase I RI. In addition, the observed concentrations of these metals in Yak Tunnel discharge were many times the chronic toxicity levels for freshwater aquatic life. For zinc, the highest concentration in the Yak Tunnel effluent was more than 900 times the chronic toxicity level for freshwater aquatic life.

The Yak Tunnel is the major contributor to contamination of California Gulch surface water. Above the Yak Tunnel, California Gulch flows intermittently during spring runoff and heavy rainstorms. Throughout much of the year, the Yak Tunnel is the primary source of continuous flow for California Gulch below the tunnel. Another source of continuous flow is the Leadville sewage treatment plant, which discharges treated effluent to lower California Gulch below Stringtown.

During the Phase I RI, EPA periodically analyzed surface water samples from six locations (SW-3A, SW-4, SW-4A, SW-7, SW-9, and SW-12) along the length of the California Gulch mainstream below the Yak Tunnel (Figure 4). This segment of California Gulch, which is approximately 4 miles long, runs adjacent to Leadville and through Stringtown before it discharges into the Arkansas River.

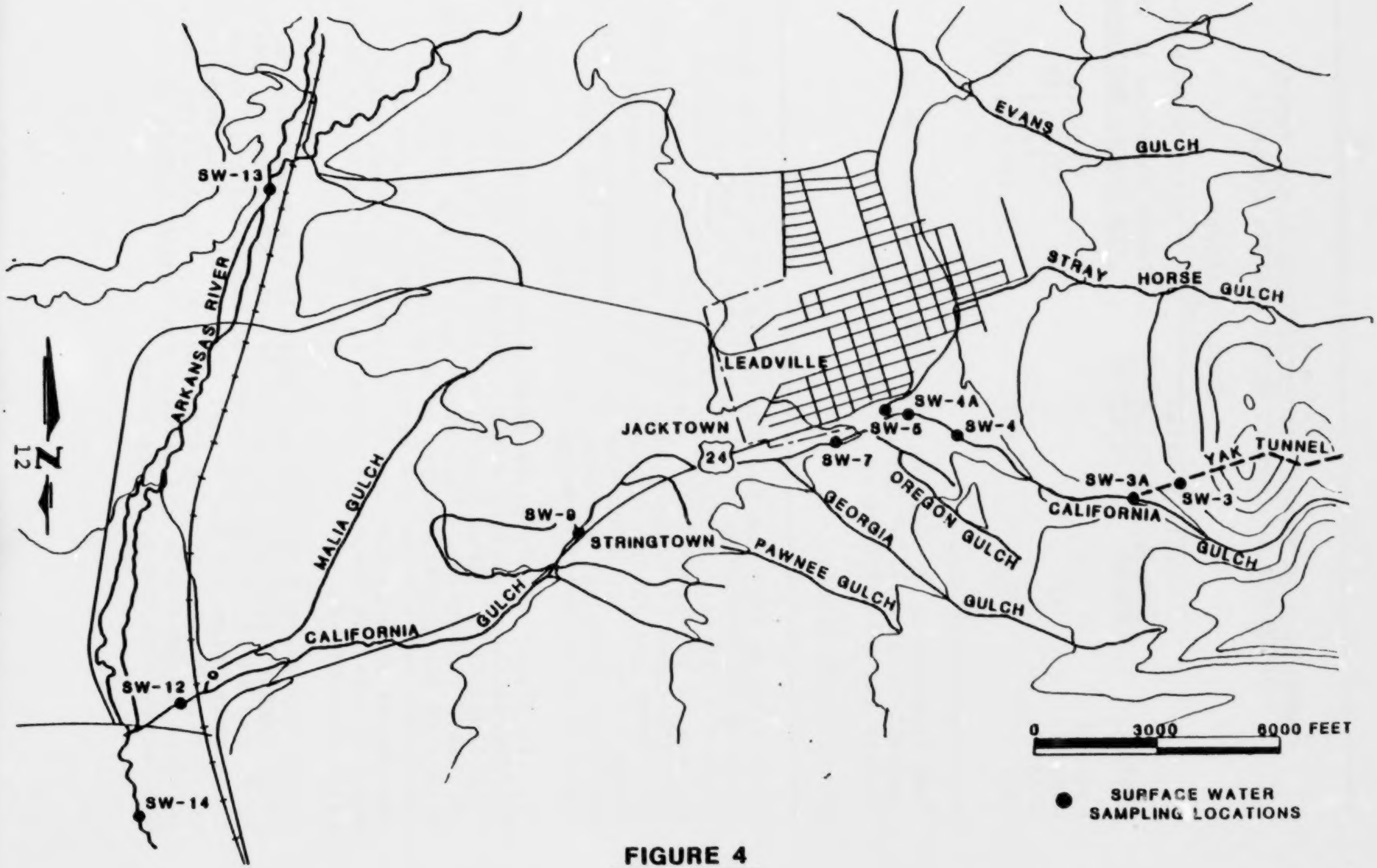
EVANS GULCH
STRAY HORSE GULCH
LEADVILLE
JACKTOWN
24
YAK TUNNEL
SW-13
SW-4A
SW-5
SW-4
SW-7
SW-3A
SW-3
CALIFORNIA GULCH
OREGON GULCH
GEORGIA GULCH
PAWNEE GULCH
SW-9
STRINGTOWN
MALIA GULCH
ARKANSAS RIVER
CALIFORNIA GULCH
SW-12
SW-14
N
0 3000 6000 FEET
● SURFACE WATER SAMPLING LOCATIONS

FIGURE 4

SURFACE WATER SAMPLING STATIONS

Table 2 shows the range of metal concentrations at various sampling locations for four metals of concern detected in California Gulch surface water. For these metals, the acute and chronic toxicity levels for freshwater aquatic life were exceeded along the entire length of California Gulch below the Yak Tunnel. At times, the observed contamination levels ranged from hundreds to thousands of times greater than the criteria value.

Table 2
COMPARISON OF RANGES OF METALS CONCENTRATIONS WITH AMBIENT WATER QUALITY CRITERIA AT SIX LOCATIONS ALONG THE MAINSTREAM OF CALIFORNIA GULCH

Criteria and Sampling Locations	Concentrations (ppb)			
	Cadmium	Copper	Lead	Zinc
Ambient Water Quality Criteria[a]				
Acute	3.9	18	82	120
Chronic	1.1	12	3.2	110
Location				
SW-3A	56-390	254-4,280	9.5-239	5,060-75,000
SW-4	178-395	810-3,980	32-270	50,390-75,900
SW-4A	200-285	778-1,390	52-55	6,440-56,100
SW-7	82-382	174-3,620	105-3,500	27,310-76,600
SW-9	105-384	441-3,470	146-4,740	27,000-77,300
SW-12	62-290	26-2,560	16-2,860	20,170-57,800

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[a] Values assume hardness of 100 mg/l $CaCO_3$.

Source: EPA, 1987a.

California Gulch contributes to contamination of surface water in the Arkansas River. In the Phase I RI, sampling points were located both above and below the confluence of California Gulch with the Arkansas River (Figure 4). Data from these locations demonstrate the impact of California Gulch on Arkansas River water quality (Table 3).

It should be noted that during the five sampling rounds, lead and cadmium were not detected in the Arkansas River upstream of the confluence with California Gulch. Below the

Table 3
COMPARISON OF METALS CONCENTRATIONS IN THE
ARKANSAS RIVER WITH AMBIENT WATER QUALITY CRITERIA

	Ambient Water Quality Criteria Concentrations[a] (ppb)			Arkansas River Concentrations (ppb)	
Metal	Acute	Chronic	Sample Date	Above Confluence	Below Confluence
Cadmium	3.9	1.1	11/84	BDL[b]	BDL
			3/85	BDL	23
			6/85	BDL	BDL
			9/85	BDL	5.8
			11/85	BDL	5.7
Copper	18	12	11/84	12	BDL
			3/85	3.8	189
			6/85	4	29
			9/85	4.6	37
			11/85	6	24
Lead	82	3.2	11/84	BDL	BDL
			3/85	BDL	439
			6/85	BDL	25
			9/85	BDL	6.8
			11/85	BDL	9.7
Zinc	120	110	11/84	331	1,625
			3/85	637	5,630
			6/85	132	709
			9/85	353	2,060
			11/85	391	1,870

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[a] Values assume hardness of 100 mg/l $CaCO_3$.
[b] BDL = below detection limit.

Source: EPA, 1987a.

confluence, the acute and chronic criteria were exceeded during three of the five sampling rounds for cadmium. Concentrations of lead exceeded the chronic criteria for four out of five sampling rounds and exceeded the acute criteria for one of the sampling rounds. The concentrations of copper also exceeded both the acute and chronic criteria below the confluence in four of the five sampling rounds. Upstream from the confluence, the zinc levels were already relatively high; however, they increased more than five times in concentration below the confluence with California Gulch and exceeded both acute and chronic criteria.

As part of the Phase I RI, EPA estimated the contribution of the Yak Tunnel to metals loading at the point of confluence with the Arkansas River. The Yak Tunnel was estimated to contribute an average of approximately 80 percent of the dissolved zinc and 85 percent of the dissolved cadmium that leaves California Gulch and enters the Arkansas River annually (EPA, 1987a). Other sources are also recognized as contributing to the contamination of both the Arkansas River and California Gulch (EPA, 1987a). During spring runoff, the relative contribution of different sources may vary substantially. Nevertheless, the Yak Tunnel is a major source of contamination year-round.

In addition, metals in the Yak Tunnel discharge contribute to contamination of the shallow alluvial ground water zone associated with California Gulch. The Phase I RI indicated that there is an interchange between California Gulch surface water and the shallow alluvial ground water zone below the Pendry Fault. Ground water monitoring indicated that the upper 25 to 50 feet of California Gulch alluvial ground water are contaminated with cadmium, zinc, and other metals and pollutants such as sulfates, which are associated with Yak Tunnel discharge. The concentrations of various metals in ground water are in excess of both primary and secondary drinking water standards (EPA, 1987a).

As illustrated in the conceptual model (Figure 3), metals from the Yak Tunnel also contribute to contamination of the stream sediment system. Metals in solution can become separated from the solution, forming precipitates that become part of the stream sediment system. These precipitates can remain suspended or settle out of the water. Yellow boy is an iron hydroxide precipitate and is a visual example of this process, which can be seen throughout the length of lower California Gulch. The sediment system's dynamic character is demonstrated at high flows when the sediments and precipitates are picked up from the stream bed and are moved further downstream.

If sediments dry out because of reduced streamflow or movement of the stream channel, contaminated materials can become wind-borne. Hence, metals from Yak Tunnel can become more widely dispersed than simply through water transport. The air pathway will be addressed in a subsequent operable unit.

PUBLIC HEALTH AND ENVIRONMENTAL IMPACTS

The surface water, ground water, and air pathways of contaminant transport may each result in exposure of living organisms to hazardous substances. Plants can take up metals from water and soils through their root systems and leaves. Aquatic organisms can absorb metals. Domestic animals and wildlife can drink contaminated water or consume plants or other animals that have taken up metals. Humans can be exposed through inhalation or ingestion of contaminated water, sediments, and food. Consequently, metals can become part of the food chain and may bioaccumulate in various organisms.

Cadmium, copper, lead, and zinc are key metals of concern. The following are brief summaries of the toxic effects of these metals:

- Cadmium--Chronic exposure to cadmium in animals and humans results in renal dysfunction, hypertension, and altered liver and kidney function. Cadmium is toxic to freshwater fish in low concentrations (a few ppb). Cadmium interferes with normal osmoregulation, liver and kidney enzymatic activities, and maturation of reproductive organs. Trout species are sensitive to cadmium and juvenile fish are commonly more sensitive than either eggs or adults. When cadmium, copper, and zinc concentrations occur together, synergistic effects increase their toxicity to freshwater organisms.

- Copper--Copper is not acutely toxic to humans. It imparts a taste to water at relatively low concentrations (a few thousand ppb), which could deter use of contaminated water. Copper is one of the most toxic metals for aquatic organisms. Chronic exposure to copper in concentrations greater than 12 ppb reduces growth and rate of reproduction, may interfere with oxygen transport across gill membranes, and has been reported to reduce the ability of fish to orient themselves properly.

- Lead--Chronic exposure to relatively low quantities of lead in humans can cause anemia, loss of appetite, intestinal cramps, and fatigue. Lead can bioaccumulate in humans, and exposure to higher lead levels can cause permanent neurological damage. The gastrointestinal absorption and retention of lead is greater in children than in adults, so children are much more susceptible to the adverse effects of ingestion of lead in water, food, and dirt. Chronic exposure to lead concentrations of 13 ppb in rainbow trout causes reduced hemoglobin production and changes in red blood cells. Lead concentrations of a few hundred ppb causes spinal deformities in brook trout. Fish that are exposed to chronic and subchronic levels of lead generally show changes in their tissue structure. Fish eggs and juveniles may be more sensitive to lead, and several other metals, than the adults.

- Zinc--Zinc is an essential element in humans and is necessary for the biosynthesis of nucleic acids and polypeptides. Zinc is rarely toxic to humans, but its synergistic/antagonistic interaction with other metals may cause problems. Susceptibility of fish to zinc is largely species-dependent. Rainbow trout and brook trout are fairly susceptible to chronic zinc exposure. Juvenile rainbow trout are about three times more resistant than eggs. Water temperature and hardness significantly influence the toxicity of zinc. Zinc toxicity causes decreased growth, kidney dysfunction, gill damage, and alterations in behavior.

Surface water contamination is the exposure mechanism of primary concern for the Yak Tunnel operable unit. Below the Yak Tunnel portal, California Gulch runs approximately 4 miles next to Leadville and through Stringtown before it discharges into the Arkansas River (Figure 4). There is unrestricted public access to the gulch for most of this length. Children and adolescents are attracted to water for exploration and recreation. Both children and adults may make other recreational use of the stream. Through such activities, people would be exposed to metals through inadvertent ingestion of contaminated material.

The Arkansas River is heavily used for irrigation, livestock watering, public water supply, recreation, and fisheries. In the upper Arkansas River Valley, the primary uses of the Arkansas River are recreational and, secondarily, irrigation and stock watering.

Further downstream, water from the Arkansas River is diverted for municipal water supplies. Flow has been diverted from the Arkansas River below Granite, Colorado, to serve the cities of Aurora and Colorado Springs. Surge events that mobilize sludges from the Yak Tunnel have affected Arkansas River water use. In 1983, during an inspection of the Yak Tunnel, ASARCO personnel released sludge or "yellow boy" that had formed behind debris dams.

The release turned a 20-mile stretch of the Arkansas River orange for several days and forced downstream cities, including Colorado Springs, Canon City, and Florence, to turn off their water intakes for 5 days. After a surge in 1985, an orange plume, which eventually dissipated in the Pueblo Reservoir, was seen more than 60 miles downstream. Again, downstream water intakes were shut down.

The State of Colorado has designated segments of the Arkansas River, including the stretch from the confluence with California Gulch to Lake Fork, for various uses, including Class 1 cold water aquatic life. This classification covers waters that, based on water quality levels, flow, and stream bed characteristics, could provide a habitat that protects a wide variety of cold water biota such as trout and other sensitive species.

However, biological studies indicate that habitat degradation from metals contamination has reduced the capacity of this segment of the Arkansas River to support well-balanced aquatic populations. Below the California Gulch confluence, both the quantity and variety of fish and macroinvertebrate populations are reduced (Roline et al., 1981). Evidence also suggests bioaccumulation of metals and negative impacts on the reproductive capacity of trout (Roline et al., 1981; La Bounty et al., 1975).

There is also the potential for the exposure of humans to metals through ground water. The previously mentioned shallow alluvial ground water zone was used as a source of domestic water. During the Phase I RI studies, EPA identified 33 existing wells that were drilled into the California Gulch alluvium. Many of these wells have been abandoned because of poor water quality. In 1986, EPA connected the one remaining household that used the aquifer as a drinking water source to the public water system. However, at this time, no steps have been taken to prevent people from using their existing wells or from drilling new wells into the contaminated alluvium.

As shown in Figure 3, there are multiple sources and pathways of metals contamination in the Leadville area. The remedy selected for the Yak Tunnel operable unit is designed to address a major source of contamination and to reduce significantly the amount of metals released into the environment. Other sources and pathways of exposure will be addressed in subsequent operable units.

IV. COMMUNITY RELATIONS HISTORY

From the beginning of the RI/FS process for the California Gulch site, EPA has conducted community relations activities and sought the involvement of potentially responsible parties. These activities have included correspondence with potentially responsible parties and members of the public, preparation of press releases and fact sheets, and periodic meetings with elected officials, potentially responsible parties, and the community to discuss the Superfund process and the status of site activities.

On July 7, 1987, EPA issued a press release announcing the availability of the Yak Tunnel FS report. In July 1987, EPA distributed a fact sheet describing the alternatives evaluated to more than 100 people on EPA's mailing list and notified the public of the opportunity to comment. EPA placed copies of the FS report in the Lake County Library in Leadville and in the EPA Region VIII library in Denver. EPA also distributed copies of the FS report to more than 40 people, including those who requested a copy during the public comment period. EPA sent copies on July 6, 1987 of the FS report to all defendants in United States v. Apache Energy and Minerals Co. and invited their comments.

On August 17, 1987, EPA issued a press release announcing the availability of the proposed remedial action plan for the Yak Tunnel operable unit. EPA placed a full-page notice in The Herald Democrat on August 20, 1987, which contained a brief analysis of the plan and alternative plans that were considered. The notice also provided information on the comment period and the date set for a public meeting. EPA sent copies of the proposed plan to the complete mailing list and to each of the defendants in United States v. Apache Energy and Minerals Co. The plan notified the public and the defendants of the timing and procedures for comment. Copies of the proposed plan were also placed in the Lake County and EPA Region VIII libraries.

EPA also made copies of the administrative record available in the Lake County and EPA Region VIII libraries on September 15, 1987. EPA sent letters to each defendant announcing the availability of the administrative record. EPA also issued a press release on September 25, 1987, and articles notifying the public of location and availability of the record appeared in The Herald Democrat on October 1, 1987, and the Rocky Mountain News on October 2, 1987. EPA responded to all requests made during the public comment period by defendants and others for technical information not yet available in the administrative record.

In addition to a 90-day public comment period, EPA held a public meeting on the FS and proposed plan at the Lake County Courthouse in Leadville on September 1, 1987. More than 40 people signed the attendance sheet. Attendees raised comments and questions on a variety of issues. At the meeting, ASARCO presented its own proposal for a Yak Tunnel operable unit remedy. The people present at the meeting also raised questions and made comments on both the EPA and the ASARCO proposals.

A court reporter prepared a transcript of the meeting. A copy of the transcript and all written comments received during the comment period have been placed in the administrative record. In addition, copies of the transcript were sent to all people who made comments at the public meeting.

Key community concerns expressed at the public meeting and in written comments included the following:

1. The technical and economic wisdom of rehabilitating the Yak Tunnel to facilitate drainage and minimize surge events;

2 The importance of worker safety during rehabilitation;

3. Problems with the need for perpetual tunnel maintenance, treatment plant operation, and sludge disposal;

4. The appropriateness and technical feasibility of meeting the proposed cleanup criteria; and

5. The potential economic impact of the proposed remedial measures on the future of the Leadville mining industry.

These issues are addressed in the "Selected Remedy" section of this ROD and the Responsiveness Summary.

V. ALTERNATIVES EVALUATION

As part of the FS, EPA developed and evaluated 11 remedial alternatives for the Yak Tunnel in accordance with CERCLA (as amended by SARA), the NCP, and EPA's "Interim Guidance on Superfund Selection of Remedy", December 24, 1986 (OSWER Directive No. 9355.0-19). In addition, EPA has evaluated alternatives proposed by ASARCO and the Leadville Corporation.

Under Section 121 of SARA, EPA must select a remedial action that is protective of human health and the environment, that is cost-effective, that attains federal and state requirements that are applicable or relevant and appropriate (ARARs), and that uses permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Additionally, SARA

Section 121 and EPA guidance documents establish a preference for remedies which employ treatment which permanently and significantly reduces the mobility, toxicity, or volume of hazardous substances as their principal element. This section summarizes how EPA's remedy selection process addresses these requirements.

DEVELOPMENT OF ALTERNATIVES

Alternatives for the Yak Tunnel operable unit were developed based on consideration of specific site and waste characteristics (see Table 5-1 of the FS report). From the universe of possible response actions, EPA defined a set of response actions and associated technologies that could address the specific site and waste characteristics (see Tables 5-3 and 5-4 of the FS report). An example of the results of this process was the elimination of incineration from further consideration because metals, such as the contaminants from Yak Tunnel, are not destroyed by heat.

Section 121(b)(1) of SARA requires an assessment of permanent solutions and alternative treatment technologies or resource recovery technologies that, in whole or in part, will result in a permanent and significant decrease in the toxicity, mobility, or volume of the hazardous substance, pollutant, or contaminant. As part of this assessment, EPA evaluated permanent solutions and alternative treatment processes that included chemical treatment and reprocessing.

Before the technologies were assembled into remedial action alternatives, they were categorized as either source control or management-of-migration measures and were prescreened based on their suitability to abate the threat from the Yak Tunnel effluent. Source control measures are designed to control the source of contamination at or near the area where the hazardous substances were originally located. For this operable unit, the sulfide zones exposed by mining activities are considered as the "source" of contamination. Management-of-migration actions are taken to mitigate the impact of the Yak Tunnel discharge. The results of this prescreening were presented in Tables 5-7 and 5-8 of the FS report.

EPA then assembled the remaining technologies and/or disposal options into 10 remedial action alternatives. Pursuant to the Interim Guidance on Superfund Selection of Remedy, EPA included alternatives ranging from those that would eliminate the need for long-term management (including monitoring) at the site, to alternatives involving treatment that would reduce toxicity, mobility, or volume as their principal element. Further, a no-action alternative was included as required by Section 300.68(f)(1)(v) of the NCP.

In addition to the 11 alternatives developed and evaluated in the FS report, EPA has added the two alternatives proposed by defendants.

DESCRIPTION OF ALTERNATIVES

The remedial alternatives evaluated in the FS report were developed to accomplish the following:

1. Seal the underground workings to eliminate the outflow of contaminated water (reduce or eliminate the need for long-term management);

2. Remove and process the sulfide mineral zone (reduce the need for long-term management);

3. Treat the contaminated outflow prior to discharge to the environment (reduce mobility and toxicity); or

4. Combinations of these alternatives.

These remedies are listed below as Alternatives 1 through 10. Alternative 11 is the no-action alternative. The alternatives proposed by ASARCO and Leadville Corporation are listed as Alternatives 12 and 13, respectively.

1. Mine Void Backfill--This alternative would involve backfilling the tunnel, the laterals, and the mined-out voids with mine tailings, waste rock, natural fill, or concrete to stop water infiltration and halt the oxidation process.

2. Total Plugging of the Yak Tunnel--Several discrete concrete plugs would be constructed within the tunnel. The water that backs up behind the plugs would flood the sulfide zone, reduce the oxidation process and, thereby, prevent the discharge of contaminated water.

3. Mining and Disposal--The sulfide zone would be mined out and disposed of in an appropriate landfill, thus halting the in situ oxidation process and the release of metals.

4. Mining, Treatment, and Disposal--This alternative is similar to Alternative 3 with the exception that economically valuable metals would be recovered from the mined sulfide rock prior to disposal. This would significantly reduce the metal content of the waste requiring land disposal and, thereby, offset disposal costs.

5. Collection, Treatment, and Discharge--This alternative would involve rehabilitating the Yak Tunnel to maintain its function in collecting the contaminated water. Shafts would be sealed and surface water diversions would be installed to minimize the inflow of snowmelt and precipitation to the Yak Tunnel and mined areas. Surge control ponds would be built to regulate the outflow from the tunnel and a water treatment facility would be constructed that would discharge treated effluent to the lower reaches of California Gulch or the Arkansas River. Among the considered treatment options were the following:

   - Chemical treatment using a lime neutralization plant or ponds;
   - Chemical treatment using selective precipitation to recover valuable minerals from the water;
   - Biological treatment using wetlands; and
   - A secondary treatment stage to further improve the effluent quality.

   EPA identified Alternative 5 as the preferred alternative in the proposed remedial action plan but retained the possibility of partial plugging.

6. Partial Plugging, Collection, and Discharge--This alternative would involve constructing one or more discrete concrete plugs in the upper reaches of the Yak Tunnel to reduce the amount of the outflow discharged to the lower reaches of California Gulch or the Arkansas River.

7. Partial Plugging, Collection, Treatment, and Discharge--This alternative combines Alternatives 5 and 6, incorporating both the installation of one or more discrete plugs and treatment of any remaining discharge. The plug(s) would reduce the quantity of contaminated outflow and, thus, reduce the size of the treatment facility and amount of tunnel rehabilitation required.

8. Partial Mining and Disposal, and Partial Plugging, Collection, and Discharge--This alternative is a combination of Alternatives 3 and 6.

9. Partial Mining, Treatment, and Disposal, and Partial Plugging, Collection, Treatment, and Discharge--This alternative combines Alternatives 4 and 7.

10. Institutional Controls--In this alternative, deed and access restrictions would be used to reduce public exposure to metals in the Yak Tunnel discharge.

11. No Action--No remedial actions would be performed.

12. ASARCO Proposal--ASARCO proposed total plugging of the tunnel with a series of four concrete plugs. In addition, surge ponds would be constructed, the ground surface would be sealed to prevent inflow, and the mine water would be treated through in situ lime treatment by lime injection. This proposal incorporates elements of Alternatives 2, 5, and 7 with the addition of the in situ, rather than external, water treatment.

13. Leadville Corporation Proposal--Leadville Corporation proposed to install a plug in the Yak Tunnel below the Resurrection Mine workings. This is a specific proposal for implementation of one element, the Resurrection plug, common to Alternatives 2, 6, 7, and 12. Leadville Corporation also proposed pumping, treatment, and discharge of water to Evans Gulch from behind the plug, until its mining operations cease.

INITIAL SCREENING

Pursuant to Section 300.68(g) of the NCP and EPA's Interim Guidance on Superfund Selection of Remedy, EPA conducted an initial screening of the 11 alternatives based on implementability (acceptable engineering practices), effectiveness, and cost. Table 7-1 in the FS summarizes the initial screening process. Alternatives 1, 2, 3, 4, 6, 8, 9, and 10 failed to pass the initial screening for the reasons described below.

Alternative 1

Alternative 1 consists of filling mine void spaces and rock fractures with mine tailings, waste rock, natural fill, or concrete to reduce water infiltration and reduce the sulfide oxidation process. This alternative was eliminated because it may not be technically feasible to fill all the mine voids and halt the oxidation process. If the mine void spaces were to be filled, the alternative would probably not be effective in reducing the generation of acidic ground water since flow through the surrounding sulfide rock would still occur. This acidic water could seep to California Gulch and possibly to other areas. The alternative was also eliminated because it would cause extensive environmental damage to the ground surface when the required access roads and drill pads are built to inject the grout and other fill materials into the mine voids. Alternative 1 far exceeds the cost of other alternatives but does not provide substantially greater public health and environmental protection, or technical reliability.

Alternative 2

Alternative 2 consists of totally plugging the Yak Tunnel by a series of plugs in an attempt to stop the discharge of flow from the portal. This alternative was eliminated because it would not be technically feasible to stop all flow from the Yak Tunnel workings. The lowermost area of the tunnel, the Iron Hill group of mine workings, is relatively near the surface and has extensive shafts, fractures, and mine workings. Once water had backed up behind the lowermost plug, it would likely seep through these conduits to the surface and consequently to California Gulch. While many of these could be plugged, it is unlikely that complete control of the seepage through surface sealing can be achieved in the Iron Hill area. This alternative did not include any activities to control or clean up acidic seepage. As a result of the uncontrolled acidic seepage to California Gulch, this alternative would not effectively protect water quality.

Alternatives 3 and 4

Alternatives 3 and 4 both entail removing the sulfide rock by mining. Alternative 3 involves disposal of the removed sulfide rock, while Alternative 4 considers recovering the metals from the sulfide rock (resource recovery) to reduce the metals content of the waste requiring disposal. Alternatives 3 and 4 were eliminated because they were considered to be unreliable, likely to create substantial adverse environmental impacts, and extremely difficult and expensive to undertake. First, identifying and removing all sulfide rock may not be possible. If all sulfide rock were not removed, the conditions resulting in the generation of acidic ground water would persist, and neither Alternative 3 nor 4 would be effective in protecting water quality. Second, the environmental impacts of such a mining effort would be substantial because it would entail exploration drilling, rock removal, backfill to prevent subsidence of mined areas, and transportation and disposal of the mined material. In addition, both Alternatives 3 and 4 far exceed the costs of other alternatives and still do not provide substantially greater public health and environmental protection, or technical reliability.

Alternative 6

Alternative 6 consists of partial plugging, collection, and discharge of the Yak portal drainage. The partial plugging would reduce flow and metals concentration at the tunnel portal. The discharge at the portal would be collected and discharged either to California Gulch or the Arkansas River. However, even with the reduction in volume and metals concentration, the water discharged from the Yak Tunnel would still contain high levels of metals. Therefore, this alternative was eliminated.

Alternatives 8 and 9

Alternatives 8 and 9 are similar in that they entail partial mining and disposal, and partial plugging, collection, and treatment for both the mined materials (to remove the sulfides and achieve resource recovery) and treatment of the tunnel discharge. Neither alternative would achieve greater reduction in mobility, toxicity, or volume of wastes than Alternatives 5 or 7. Alternatives 8 and 9 were eliminated for the same reasons as Alternatives 3 and 4; they are unreliable, likely to create adverse environmental impacts, and extremely difficult to undertake.

Alternative 10

Alternative 10 uses institutional controls to minimize the impact from the Yak Tunnel. Institutional controls, such as fences, culverts, and land use restrictions, are technically feasible and relatively simple to implement. However, implementation of institutional controls would have no impact on the generation and discharge of metal-laden acidic water from the Yak Tunnel. Since Alternative 10 would provide little benefit, if any, to protection of public health and the environment, it was eliminated.

Alternatives 12 and 13

Alternatives 12 and 13 did not receive initial screening since they were proposed after EPA had completed the FS. However, EPA retained them, as well as Alternatives 5, 7, and 11, for detailed analysis.

DETAILED DESCRIPTION OF REMAINING ALTERNATIVES

The five alternatives retained for further analysis include elements of source control (tunnel plugging and flooding of sulfide zones to control oxidation), management of migration (collection and treatment of contaminated water), permanent solutions (tunnel plugging, flooding of sulfide zones, and surface sealing), and alternative treatment technologies (collection and treatment of contaminated water). In addition, several of these alternatives (5, 7, 12, and 13) use techniques that may significantly reduce the mobility, toxicity, or volume of hazardous substances.

The five alternatives selected for detailed analysis are described in detail below.

Alternative 5--Collection, Treatment, and Discharge

This alternative is a management-of-migration technique to collect and treat the Yak Tunnel flow. The tunnel would be rehabilitated to maintain its function as a drainage system, which would control surges and releases of precipitates. The portal flow would be routed through surge ponds in the Resurrection Mill Yard. These ponds would be built to control discharges during construction and then would be used as equalization ponds to control the flow to a treatment plant.

Water would be pumped to a treatment facility located outside the 100-year floodplain. The plant would use chemical or biological treatment processes. Secondary treatment would be added if necessary to meet cleanup standards. After treatment, the water could be discharged to either California Gulch or the Arkansas River. Waste sludge from the treatment facility would be disposed of onsite in a properly designed and maintained landfill.

Alternative 7--Partial Plugging, Collection, Treatment, and Discharge

This alternative uses both source control and management-of-migration technologies. Source control would be achieved by placing concrete plugs in the Yak Tunnel below both the Resurrection and the Ibex-Irene mine workings. These plugs would decrease acid mine drainage flow rates from the portal by about 50 percent. Partial plugging would also reduce the area of the tunnel and laterals that would require rehabilitation and subsequent maintenance. The remaining acid drainage from the tunnel would be collected via the rehabilitated tunnel collection system described in Alternative 5. The treatment plant options (adjusted for reduced flow and waste disposal) would be the same as those for Alternative 5.

Alternative 11--No Action

Under the no-action alternative, there would be no remediation of the Yak Tunnel discharge.

Alternative 12--ASARCO Proposal (Total Plugging, Collection, and In Situ Treatment)

During the public comment period, ASARCO proposed a detailed alternative that uses both source control and management of migration technologies (ASARCO, 1987). This alternative involves total plugging of the Yak Tunnel with placement of concrete plugs below the Resurrection mine workings, in the Irene-Ibex area, and near the portal. The water behind the portal plug would be pumped to the surface, mixed with lime, and subsequently discharged back into the mine workings via injection wells. The pumping, treatment, and reinjection would continue until water quality within the mine workings was acceptable. If necessary, water levels would be lowered behind the portal plug and the pumped-out water would be treated before discharge.

ASARCO also proposed diversion of surface water, construction of surge ponds, and development of a monitoring network.

Since this combination of response actions was not evaluated in the FS, a more detailed description follows:

1. Tunnel Plugging. Concrete plugs would be installed at four locations in the Yak Tunnel: below the Resurrection mine workings, below the Ibex area, in the Irene lateral, and near the portal. The plugs would minimize the migration of water from the mine workings through the tunnel and would inundate a large portion of the sulfide zone.

2. Surface Water Diversions. To minimize the amount of surface water infiltrating the tunnel, ASARCO proposed constructing a surface water diversion channel and a ground water cutoff wall upstream of the diversion channel, and backfilling all shafts in the bottom of upper California Gulch.

3. Surge Ponds. Surge ponds would be constructed on two tailing impoundments located near the Yak Tunnel portal. The surge ponds would be needed to protect the downstream waters during construction of the tunnel plugs. Once the plugs are installed, the surge ponds would be dismantled. This component would also involve stream channel relocation and stabilization of the two tailings impoundments.

4. In Situ Treatment. ASARCO proposes to treat the water impounded behind the portal plug by injecting lime into the old mine workings. The proposal consists of a well and pump station in California Gulch, surface piping to injection wells, and a portable lime addition system. According to ASARCO, this in situ treatment system would pump water from old mine workings, add lime, and reinject high pH water into six major mine workings. The high pH water would precipitate metals and form a sludge, which would eventually settle out and possibly seal the seeps. After determining that the entire stored water volume has been adequately treated, the injection process would be stopped until

monitoring revealed the need for additional lime neutralization.

5. Monitoring and Contingency Plan. Several monitoring wells would be installed around the periphery of the Yak Tunnel hydrologic unit to establish baseline data on water quality and levels and to detect any changes as the treatment process proceeds. The California Gulch pumping system would be used to control water levels if surface seeps or other detrimental effects are seen.

ASARCO did not provide information regarding the following:

1. Necessary pump rates and lime additions that would be required under various hydrologic conditions;

2. Data to permit evaluation of the adequacy of mixing lime with metal-laden water in the underground workings to control the treatment process; and

3. A specific program to locate seeps and monitor ground water movement to determine whether the system is working properly.

Alternative 13--Leadville Corporation Proposal (Partial Plugging and Discharge)

Leadville Corporation has also developed a proposed remedy for a component of the Yak Tunnel. This remedy consists of the following components:

1. Tunnel Plugging. A concrete plug would be installed in the Yak Tunnel below the Resurrection mine workings. The purpose of the plug is to prevent migration of water from the Resurrection area through the tunnel portal. Leadville Corporation estimated that this plug would reduce the portal flow by 20 to 25 percent.

2. Collection and Treatment. During mining operations, Leadville Corporation would collect and treat the mine drainage water impounded behind the Resurrection plug. After treatment, the water would be discharged to Big Evans Gulch pursuant to a National Pollutant Discharge Elimination System (NPDES) permit. Sludge from the treatment plant would be transported to the Leadville Corporation's Stringtown Mill for processing and disposal. After mining operations ceased in the Resurrection workings, the mine drainage water would be allowed to rise behind the Resurrection plug.

DETAILED ANALYSIS OF ALTERNATIVES

CERCLA (as amended by SARA), the NCP, and EPA guidance establish criteria to be considered in evaluating and comparing alternatives. EPA's "Additional Interim Guidance for FY '87 Records of Decision," dated July 24, 1987 (OSWER Directive No. 9335.0-21), identifies nine key criteria to be considered in the preparation of RODs:

- Compliance with applicable, relevant or appropriate requirements (ARARs);
- Reduction of toxicity, mobility, or volume;
- Short-term effectiveness;
- Long-term effectiveness and permanence;
- Implementability;
- Cost;
- Community acceptance;
- State acceptance; and
- Overall protection of human health and the environment.

Table 4 provides a summary of Alternatives 5, 7, 11, 12, and 13 with respect to each of these criteria. The key factors affecting remedy selection decisions are described in more detail below for each alternative.

Alternative 5--Collection, Treatment, and Discharge

As described in the proposed remedial action plan (EPA, 1987c), EPA chose Alternative 5 as the preferred alternative for the Yak Tunnel operable unit. This alternative, which is supported by the State of Colorado and some members of the community, was selected for the following reasons:

1. The alternative would be protective of human health and the environment because the treatment system would improve the quality of the tunnel discharge;
2. The treated effluent would attain chemical-specific ARARs, except for water quality criteria for chronic toxicity for freshwater aquatic life for cadmium, copper, and lead;
3. The treatment system and sludge disposal facility would reduce the mobility of hazardous substances;

Table 4
COMPARISON OF ALTERNATIVES

No.	Criteria	Alternative No. 11 No Action	Alternative No. 5 Collection, Treatment, and Discharge	Alternative No. 7 Partial Plugging, Collection, Treatment, and Discharge	Alternative No. 12 ASARCO Proposal Total Plugging, Collection, and In Situ Treatment	Alternative No. 13 Leadville Corp. Partial Plugging and Discharge
1.	Compliance with ARARs[a]	MCLs and AWQC will continue to be exceeded	Will meet MCLs; will not meet AWQC for certain metals	Will meet MCLs; will not meet AWQC for certain metals	Seeps may not meet MCLs and AWQC	Tunnel discharge will not meet MCLs and AWQC
2.	Reduction of mobility, toxicity, or volume	None	Yes	Yes	Yes	Yes
3.	Short-term effectiveness	Not applicable	Is effective	Is effective	Plugging is effective; in situ treatment may not be effective	Is partially effective
4.	Long-term effectiveness and permanence	Not applicable	Is effective; requires perpetual care	Is effective, requires perpetual care	Plugging is effective; in situ treatment may not be effective; remedy may require perpetual care	Is partially effective; may require perpetual care
5.	Implementability	Not applicable	Yes	Yes	Yes	Yes
6.	Cost[b]	Not applicable	$23.9 million	$19.8 million	Unknown[c]	Unknown[d]
7.	Community Acceptance	Not acceptable	Some object to high cost, waste disposal, and perpetual care; others consider the system acceptable	Some object to high cost, waste disposal, perpetual care, and risks from plugging; others consider the system acceptable	Some felt it could work and eliminate perpetual care; others felt there were risks from plugging that would encumber future mining development	Majority considered it compatible with most other solutions
8.	State acceptance	Not acceptable	Acceptable	Acceptable	Acceptable as part of a total plug and treat remedy	Acceptable as part of a total plug and treat remedy
9.	Protection of human health and the environment	Adverse impacts to public health and environment will continue	Prevents surges and improves water quality	Prevents surges and improves water quality	Prevents surges and may improve water quality	May improve water quality

---

[a] As discussed in Appendix C of this ROD, MCLs are maximum contaminant levels of drinking water, and AWQCs are ambient water quality criteria for acute and chronic toxicity to freshwater life.

[b] Cost = present worth, including capital cost and opertions and maintenance cost, at a 10 percent discount rate.

[c] ASARCO estimated a capital cost of $2,932,000, and estimated an annual operation and maintenance cost of $100,000.

[d] Leadville Corporation did not provide capital nor operation and maintenance cost data. EPA estimates the capital cost of the Resurrection plug installation to be $360,000.

4. Tunnel rehabilitation would prevent or minimize surges;

5. The alternative could be implemented with presently available technologies; and

6. Maintenance using current engineering practices would provide long-term effectiveness.

Nevertheless, there are also significant drawbacks to Alternative 5. By maintaining the tunnel and major laterals, the sulfide zones would still be exposed to oxygenated water, which would permit mobilization of metals in the sulfide zones in perpetuity. The remedy would require perpetual tunnel maintenance, treatment system operation, and sludge disposal. Even if there were resource recovery from the sludge, land disposal would still be necessary. Leakage and loss of metals to the environment is still a possibility, even with a properly designed disposal system.

In addition, tunnel rehabilitation may be technically difficult, and there are short-term and long-term risks to worker health and safety associated with tunnel rehabilitation and maintenance. Some members of the community strongly oppose the tunnel maintenance component and the associated need for perpetual treatment.

Alternative 7--Partial Plugging, Collection, Treatment, and Discharge

This alternative would be protective of human health and the environment through the decrease in both chronic metals discharge and periodic surges. The remedy would reduce both the volume of water to be treated and mobility of contaminants through partial inundation of the sulfide zone and blockage of water behind the plugs. The plugs would reduce the amount of water flowing to the treatment plant by approximately 50 percent, compared to Alternative 5. As with Alternative 5, the treated effluent would attain chemical-specific ARARs, except for the water quality criteria for chronic toxicity to freshwater aquatic life for cadmium, copper, and lead. In addition, the partial plugging component would reduce the costs of tunnel rehabilitation and maintenance, the capital and operating costs of the treatment plant, and the costs and potential environmental harm associated with sludge disposal. For these reasons, this alternative has somewhat greater community acceptance than Alternative 5.

Alternative 7 has drawbacks similar to those of Alternative 5. Although of a lesser magnitude, perpetual tunnel maintenance, treatment system operation, and sludge disposal would be required. There would also be similar, although reduced, threats to worker safety. There is also uncertainty about how plugging would affect the quality and flow of water behind the plugs. The primary concern would be uncontrolled seepage or contamination of clean ground water areas. Some members of the community are opposed to the plugging component for these reasons.

Alternative 11--No Action

This alternative is not protective of public health and the environment because the contribution of the Yak Tunnel to contamination of surface water, ground water, and the sediment system would continue unabated. In addition, the risk of surges would continue, the chemical-specific ARARs would not be attained, and there would be no reduction in mobility, toxicity, or volume of the contaminants. This alternative is not acceptable to the State or the community.

Alternative 12--Total Plugging, Collection, and In Situ Treatment

This alternative would be protective of human health and the environment through the decrease in both chronic metals discharge and periodic surges. The remedy would reduce the mobility and volume of contaminants released into the environment through partial inundation of the sulfide zone and blockage of water behind the plugs. The in situ treatment component of the remedy would further reduce the mobility of contaminants and could minimize the need for above-ground landfill disposal of sludge. The remedy is implementable using existing technology and the in situ treatment component offers the potential for a permanent solution. Some community members supported this alternative principally due to its potentially lower costs and possible elimination of the need for perpetual operation and maintenance.

Alternative 12 also has significant drawbacks. Due to the complexity of the mine workings, there is a significant possibility that in situ treatment, as proposed, would not achieve sufficient mixing and would, thus, ineffectively treat water in all areas of the tunnel and connected mine workings. Sludge from the treatment system may seal off fracture flow paths causing short circuiting of the system, thus rendering the treatment ineffective. Consequently, as water levels rise behind the portal plug, there could be uncontrolled seepage of water that would not meet chemical-specific ARARs. Surface seeps of contaminated water or movement of contaminated ground water toward clean water areas could necessitate operation of a pumping and treatment system, perhaps in perpetuity. This would negate the benefits of in situ treatment and would result in long-term maintenance and sludge disposal requirements.

There is also a concern that buildup of sludge in the old mine workings, which would result from in situ treatment, would interfere with future resource development. The concern is that it would be difficult to collect, remove, and treat the sludge. The State believes that the uncertainty associated with the effectiveness of in situ treatment should be resolved through further study prior to implementation of that system.

Alternative 13--Partial Plugging and Discharge

This alternative would be protective of public health and the environment in that it would reduce flow from the Yak Tunnel by 20 to 25 percent. After mining ceases, the remedy would reduce both the mobility and volume of contaminants through inundation of mineralized zones and by blocking the discharge of additional effluent from the Yak Tunnel. The remedy is implementable using existing technology for plugging and is expected to be a permanent remedy for that portion of the tunnel. The State and many community members support construction of a plug below the Resurrection workings.

This alternative is not a total solution. There would still be substantial flow from the Yak Tunnel and the discharge would exceed chemical-specific ARARs. Additionally, the Leadville Corporation proposal did not provide for monitoring or contingency planning, which would be necessary to ensure that plugging did not result in unacceptable environmental impacts.

VI. SELECTED REMEDY

The goal of the selected remedy is to decrease the release and threatened release of hazardous substances, pollutants and contaminants from the Yak Tunnel into California Gulch. The selected remedy consists of the following components:

- Surge ponds;
- Tunnel plugging;
- Water control measures, including sealing of drill holes, shafts, and caved-in underground mine workings to reduce surface inflow to the Yak Tunnel system, and grouting of other areas to minimize ground water outflow from the flooded tunnel system after plugging;
- A monitoring system, including surface and ground water components, to determine hydrologic changes;

- A water collection (pumping) system to control water levels behind the lower plug and an interim water treatment facility using ponds (built originally for surge control) as settling ponds;
- Operation and maintenance of components of the remedy; and
- Contingency plans.

The components of the remedy are shown schematically in Figure 5. Many of these components are part of various alternatives described in the previous section and were evaluated in the FS. Specific design details of the selected remedy will be developed during remedial design.

This remedy differs from the remedy described in the proposed remedial action plan (EPA, 1987c). EPA initially identified Alternative 5 as the preferred remedy but retained the option to incorporate a partial plugging component. Subsequently, EPA received additional information during the public comment period and, after taking these comments into consideration, re-evaluated alternatives containing a plugging component and various treatment options. Based on the comments received, EPA also modified the remedy to reflect concerns about integration of the Yak Tunnel operable unit into the overall site remedy.

DESCRIPTION OF SELECTED REMEDY

The selected remedy for the Yak Tunnel operable unit consists of the components described above. The remedy incorporates a source control technology (tunnel plugging) and a management-of-migration technique (a mine water collection and treatment system). Each component is described in more detail below.

Surge Ponds

Before the plugs are installed in the Yak Tunnel, a surge pond system will be constructed at the portal. To protect California Gulch and the Arkansas River from accidental releases, the ponds will collect any surges of acidic waters, sludges, or sediments from the tunnel caused by construction. The ponds will be large enough to contain approximately 8 million gallons of water, or about six to eight times the discharge volume that was estimated during the October 1985 surge event (EPA, 1987b). The ponds and suitably sized ditches will be excavated to maintain a working depth of about 10 feet. The ponds will be lined with a synthetic membrane and clay to minimize leakage. A bypass channel, sized to accommodate the flow from a 100-year flood event from upper California Gulch, will be built to protect the surge ponds. Once the tunnel plugs have been installed, the ponds will not be needed for surge control. They will then be used as part of the interim treatment facility, which is described later in this subsection.

Tunnel Plugging

A minimum of three concrete plugs will be installed in the Yak Tunnel as shown in Figure 5. The plugs will be constructed in sound, low permeability rock and will be downgradient from each major group of interconnected mine workings (Resurrection Group, Ibex-Irene Group, and the Iron Hill Group). The Resurrection plug will be located in the vicinity of the small rhyolite breccia pipe that separates the Resurrection Mine Group from the Ibex-Irene Group. Installation of the plug will reduce inflow to the Yak Tunnel from the Resurrection group. The Ibex-Irene plug will be located just to the west of the Weston Fault Zone within the large mass of gray porphyry rock underlying Breece Hill. This plug will reduce mine water drainage from the Ibex-Irene group to the Yak Tunnel. The portal plug, to be built just below the Iron Hill group of mine workings, will probably be placed about 1,500 feet inside the tunnel portal because of the highly weathered rock (fractured) and generally unstable tunnel condition near the portal.

Access for construction of the Resurrection and Ibex-Irene plugs can initially be gained through either the Resurrection workings or the Irene 1,200 lateral (see Figure 5). Construction access for the portal plug will require either tunnel rehabilitation or construction of a new access shaft.

Plugging will seal off the major flow route for ground water movement. As a result, ground water levels in the mine workings and the surrounding rock will rise to a new equilibrium level. The current equilibrium ground water level in the vicinity of the Yak Tunnel is at the floor elevation of the tunnel, which is approximately 10,330 feet msl. The tunnel acts as a drain for the mine workings and the surrounding fractured rock. It can collect surface infiltration and ground water located in the rock mass up to several thousand feet from the tunnel. This low ground water level throughout the mine workings and mineralized rock results in a maximum exposure of sulfide-bearing rock where it is subject to oxidation. These conditions are conducive to acid mine drainage formation and result in the high metals concentrations in the Yak Tunnel portal flow.

The approximate maximum elevation of sulfide rock in the Resurrection group of workings is estimated to be

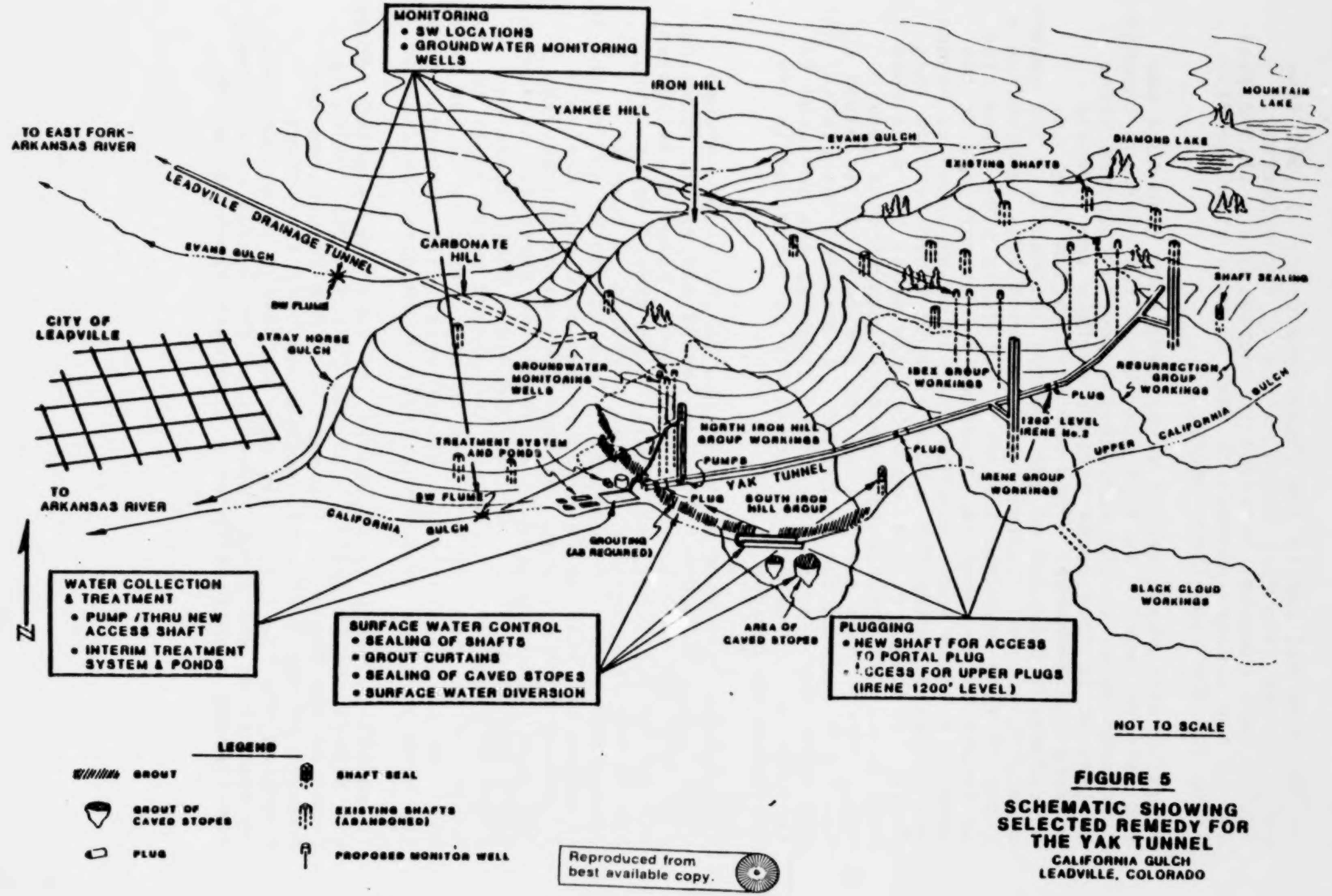
MONITORING
• SW LOCATIONS
• GROUNDWATER MONITORING WELLS
IRON HILL
YANKEE HILL
TO EAST FORK-ARKANSAS RIVER
LEADVILLE DRAINAGE TUNNEL
EVANS GULCH
EVANS GULCH
CARBONATE HILL
SW FLUME
CITY OF LEADVILLE
STRAY HORSE GULCH
GROUNDWATER MONITORING WELLS
TREATMENT SYSTEM AND PONDS
TO ARKANSAS RIVER
SW FLUME
CALIFORNIA GULCH
NORTH IRON HILL GROUP WORKINGS
PUMPS
YAK TUNNEL
PLUG
SOUTH IRON HILL GROUP
GROUTING (AS REQUIRED)
AREA OF CAVED STOPES
PLUG
IRENE GROUP WORKINGS
1200' LEVEL IRENE No.2
PLUG
IBEX GROUP WORKINGS
RESURRECTION GROUP WORKINGS
UPPER CALIFORNIA GULCH
BLACK CLOUD WORKINGS
EXISTING SHAFTS
DIAMOND LAKE
MOUNTAIN LAKE
SHAFT SEALING
N
WATER COLLECTION & TREATMENT
• PUMP /THRU NEW ACCESS SHAFT
• INTERIM TREATMENT SYSTEM & PONDS
SURFACE WATER CONTROL
• SEALING OF SHAFTS
• GROUT CURTAINS
• SEALING OF CAVED STOPES
• SURFACE WATER DIVERSION
PLUGGING
• NEW SHAFT FOR ACCESS TO PORTAL PLUG
• ACCESS FOR UPPER PLUGS (IRENE 1200' LEVEL)
NOT TO SCALE
LEGEND
GROUT
GROUT OF CAVED STOPES
PLUG
SHAFT SEAL
EXISTING SHAFTS (ABANDONED)
PROPOSED MONITOR WELL

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FIGURE 5

SCHEMATIC SHOWING SELECTED REMEDY FOR THE YAK TUNNEL
CALIFORNIA GULCH
LEADVILLE, COLORADO

10,700 feet msl and in the Ibex-Irene Group, 11,300 feet msl. In the Iron Hill Group, it is at approximately 10,700 msl; however, it rises to approximately 11,300 feet msl in the unmined segment of rock between the Iron Hill Group and the Ibex-Irene Group.

Plugging will cause ground water levels to rise to a new equilibrium level. At this new level, the outflows through fractured rock, to the surrounding regional ground water bodies, or in some cases through surface seeps, would balance the recharge. This new equilibrium level is, therefore, a function of the average permeability and amount of mining-induced fracturing of the rock mass surrounding a group of mine workings behind a particular plug. The rise in ground water level can inundate all or portions of the exposed sulfide rock, thereby preventing exposure to oxygen, and hence, reducing the amount of acid mine drainage that forms. A simple ground water balance model was developed to determine the approximate impacts of plugging on ground water level, flow directions, and quality. It is based on the model used in the FS report. A detailed description of the model and the results of the analyses are outlined in Appendix A. A summary of the result is contained in the following paragraphs.

Immediately following installation of the plugs, ground water levels will begin to rise behind the plugs, reducing flow from the Yak Tunnel to near zero. Based on estimates of rock permeability, the equilibrium ground water level behind the Resurrection plug is expected to rise to approximately 10,750 feet msl. This should be sufficient to inundate the sulfide rock and reduce acid mine drainage formation to a minimum. Furthermore, since the surface topography in this area is above 11,100 feet msl, no surface seeps should develop. Should the Black Cloud operation cease to pump its mine water, the ground water level in the Resurrection area may increase to approximately 10,900 feet msl. At this elevation, a ground water flow component from the mine workings toward the Evans Gulch area could occur.

In addition, there is a possibility that the selected remedy may affect the Leadville Drainage Tunnel (LDT), which is owned by the Bureau of Reclamation. EPA recognizes the concern of the Bureau of Reclamation over the effect plugging the Yak Tunnel may have on levels of ground water contamination and flow. Currently, the Bureau is seriously considering construction of a treatment plant to remove heavy metals from the effluent discharged from the nearby LDT. Attention must be focused on avoiding a change in quality or quantity of flow toward the area drained by the LDT that would alter the LDT discharge and exceed the capabilities of the Bureau's proposed treatment facility.

Once the Yak Tunnel is plugged, EPA's conceptual model suggests a slight increase in ground water flow in the general direction of the LDT, from 10 to 25 gpm (0.02 to 0.05 cfs). EPA believes this potential increase in flow will not adversely affect the Bureau's treatment facility. However, if EPA has underestimated the actual change in flow that results from plugging, as discussed below, the selected remedy includes an extensive ground water monitoring system that is intended to identify any adverse change in flow or contamination in a time frame that would permit the control systems included in this remedy to alleviate the potential problem. In any event, EPA intends that the selected remedy be designed and implemented in a manner that will not adversely affect the Bureau's LDT treatment facility by subjecting it to unanticipated ground water flow or contamination.

The equilibrium level in the Ibex workings behind the plug is expected to rise to about 10,650 feet msl. In the Irene area, the level is expected to be much lower due to the influence of mine water pumping from the Black Cloud workings. These levels are insufficient to inundate all the sulfide rock; acid mine drainage formation will probably continue. Ground water from this area is expected to flow in a westerly and southerly direction. Because the topography in this area is generally above 11,000 feet msl, no surface seeps are expected to result. Should the Black Cloud Mine cease pumping, the equilibrium level would rise to approximately 10,800 feet msl in both the Ibex and Irene Groups. This level is still inadequate to prevent acid mine drainage formation but is still low enough not to cause any surface seeps in the area.

The equilibrium ground water level behind the portal plug is difficult to predict because the rock in the area is extensively fractured and faulted, and near-surface mine workings are present. It is, therefore, not possible to estimate the permeability of this rock mass with any degree of reliability. Without sealing of these fractures, contaminated mine water will seep to the surface at various locations as the water levels rise behind the portal plug. As described below, the selected remedy includes sealing of these highly fractured rock areas and other water control measures. If these measures are successful and an equilibrium level of 10,500 feet msl can be achieved, much of the sulfide rock exposed in the mine workings would be inundated. However, sulfide rock at the eastern boundary of the workings and in the unmined rock between the Iron Hill Group and the Ibex-Irene plug will still be exposed and contribute to the development of acid mine drainage.

Due to the large, geologically complex area potentially affected by installation of the portal plug, without full-scale field testing it is impossible to predict the effectiveness of plugging and sealing in controlling the release of acidic waters. Should uncontrolled seepage continue after extensive sealing, the water level behind the plug would be lowered by using a pumping system to the point at which seepage would not occur. Contaminated waters from the workings behind the portal plug would be pumped, treated, and released to California Gulch. Details of the pumping and treatment system are discussed later in more detail.

Water Control Measures

During the RI, it was determined that there is recharge to the Yak Tunnel drainage system from surface waters entering through shafts and caved-in areas. This recharge adds to the amount of contaminated waters generated in the mine workings. To reduce infiltration to the system, actions will be taken to seal shafts and other recharge areas, and to prevent infiltration of surface waters from known or suspected recharge areas such as the White Cap lateral east of the Yak Tunnel portal.

As mentioned previously, after the plug is installed, water levels will rise behind the portal plug. Fracture zones, caved-in areas, and drill holes will become leakage points that must be located and grouted with acid-resistant concrete to prevent the surface discharge of acidic waters. Additional geologic mapping, geophysical investigations, and other site activities will need to be conducted during the design phase to address the sealing of these surface infiltration and leakage locations.

Monitoring

Because of the size and complexity of the Yak Tunnel system, tunnel plugging presents a risk of uncontrolled seepage and migration of contaminated ground water. Therefore, the monitoring program is an integral part of the remedial action. The general objectives of the program are as follows:

- Define the preremediation ground water and surface water conditions against which the impacts of the selected remedy can be evaluated;

Appendix A
HYDROGEOLOGIC IMPACT OF SELECTED REMEDY

Appendix A
HYDROGEOLOGIC IMPACT OF SELECTED REMEDY

CONCEPTUAL BLOCK MODEL

Possible hydrogeologic impacts have been projected based on a conceptual block water balance model of the ground water system in the vicinity of the Yak Tunnel. This is the same model that was used in the FS. The analysis, which is based on limited data, is primarily intended to allow comparisons to be made among plugging scenarios and to focus the monitoring program on areas of possible concern. The projections also provide an estimate of potential impacts of the remedy under conditions that may not be realized in the near future. For example, the operation of the Black Cloud mine has an impact on the current hydrogeology of the Yak Tunnel system. Currently, the Black Cloud operation is pumping to dewater the mine workings. When pumping ceases, there will be changes in the hydrogeologic regime. The potential changes have been considered. The model incorporates the ground water system in the immediate vicinity of the Yak Tunnel as shown in Figure A.1. How this model fits within the regional ground water system is shown schematically in Figure A.2. The details of the model are shown in Figure A.3. Figure A.4 shows the oxide/sulfide mineral interface at various locations in the study area.

REGIONAL SETTING

It is important to recognize that the ground water model covers only a portion of the regional ground water flow system. The relationship of the Yak Tunnel model to the regional system is indicated in Figure A.2 by inflows to and outflows from the model area. These are referred to as Q_R in Figure A.2. Modeled inflows and outflows in the Yak Tunnel system change significantly under the various plugging scenarios because of changes in the configuration of the potentiometric surface. These changes influence ground water flow directions and flow rates to or from the surrounding regional system.

Under equilibrium conditions, the inflow and outflow from the regional ground water flow system, including the Yak Tunnel component, will be in balance. Since the total regional flow is primarily controlled by the amount of available recharge, this total flow is unlikely to change significantly as a result of tunnel plugging. However, the flows within the various components will change.

At the present time, the interconnected mining areas drained by the Yak Tunnel act as a major discharge area for the regional ground water system (see the area described as

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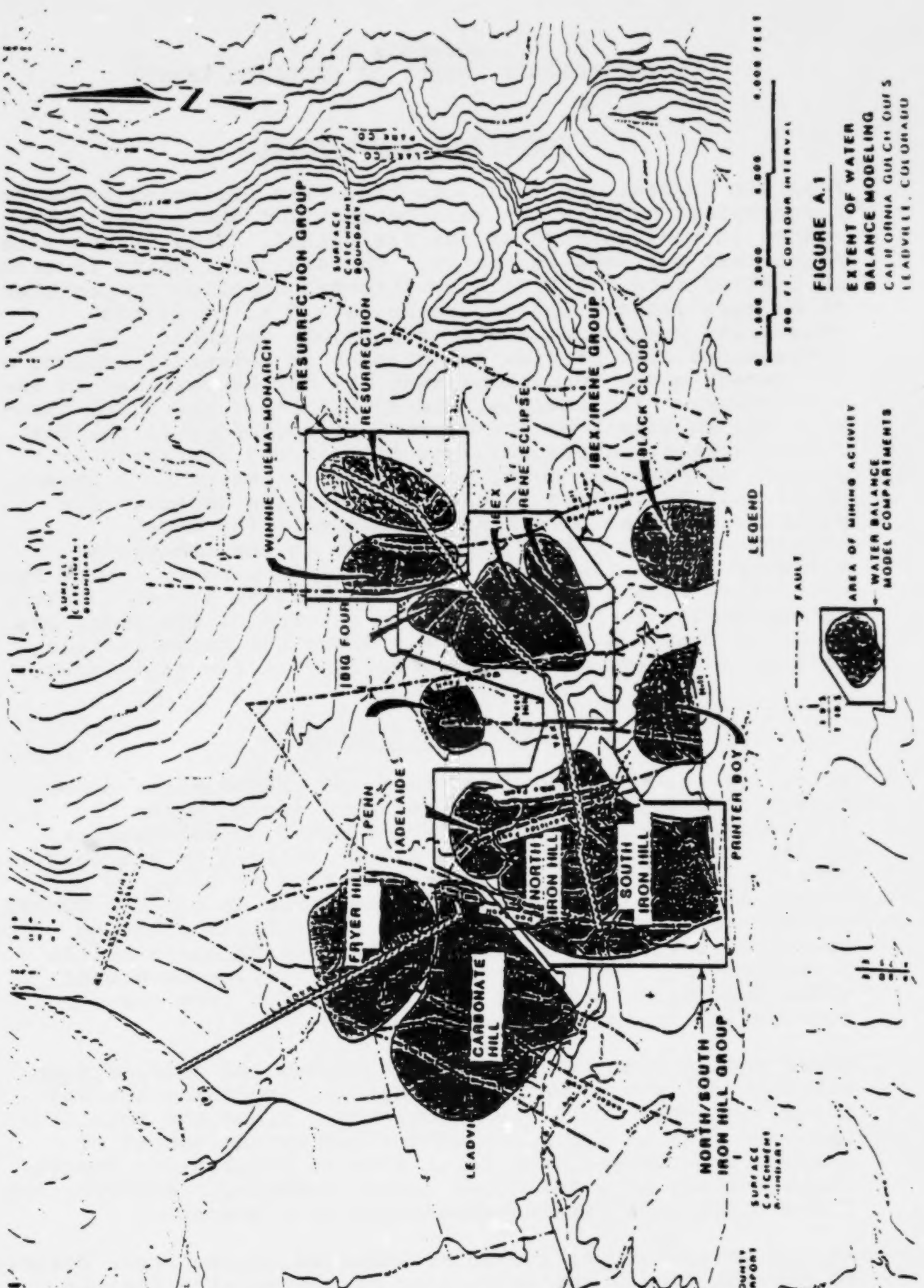
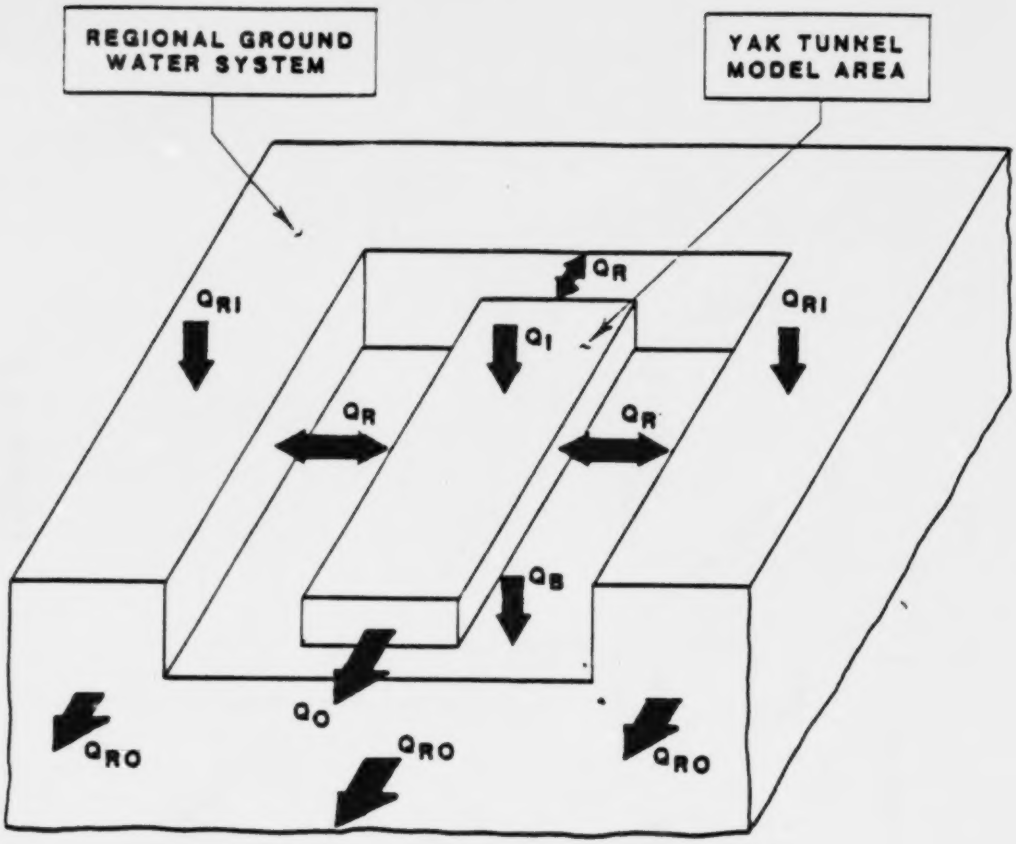

N
WINNIE-LUEMA-MONARCH
RESURRECTION GROUP
RESURRECTION
SURFACE CATCHMENT BOUNDARY
LAKE CO.
PARK CO.
BIG FOUR
IBEX
IRENE-ECLIPSE
IBEX/IRENE GROUP
BLACK CLOUD
ADELAIDE
PENN
FRYER HILL
CARBONATE HILL
NORTH IRON HILL
SOUTH IRON HILL
PRINTER BOY
NORTH/SOUTH IRON HILL GROUP
LEADVILLE
SURFACE CATCHMENT BOUNDARY
COUNTY AIRPORT
LEGEND
FAULT
AREA OF MINING ACTIVITY
WATER BALANCE MODEL COMPARTMENTS
0 1,000 2,000 4,000 8,000 FEET
200 FT. CONTOUR INTERVAL

FIGURE A.1

EXTENT OF WATER BALANCE MODELING
CALIFORNIA GULCH OU'S
LEADVILLE, COLORADO


REGIONAL GROUND WATER SYSTEM
YAK TUNNEL MODEL AREA
Q_R
Q_{RI}
Q_I
Q_{RI}
Q_R
Q_R
Q_B
Q_O
Q_{RO}
Q_{RO}
Q_{RO}

LEGEND:

YAK TUNNEL MODEL AREA

Q_I = INFILTRATION

Q_R = INTERCHANGE WITH REGIONAL GROUND WATER SYSTEM

Q_B = BEDROCK FLOW

Q_O = OUTFLOW (SEEPAGE & PORTAL FLOW)

REGIONAL GROUNDWATER SYSTEM

Q_{RI} = INFILTRATION

Q_{RO} = OUTFLOW

FIGURE A.2

SCHEMATIC PRESENTATION OF YAK TUNNEL MODEL IN RELATION TO REGIONAL GROUND WATER SYSTEM

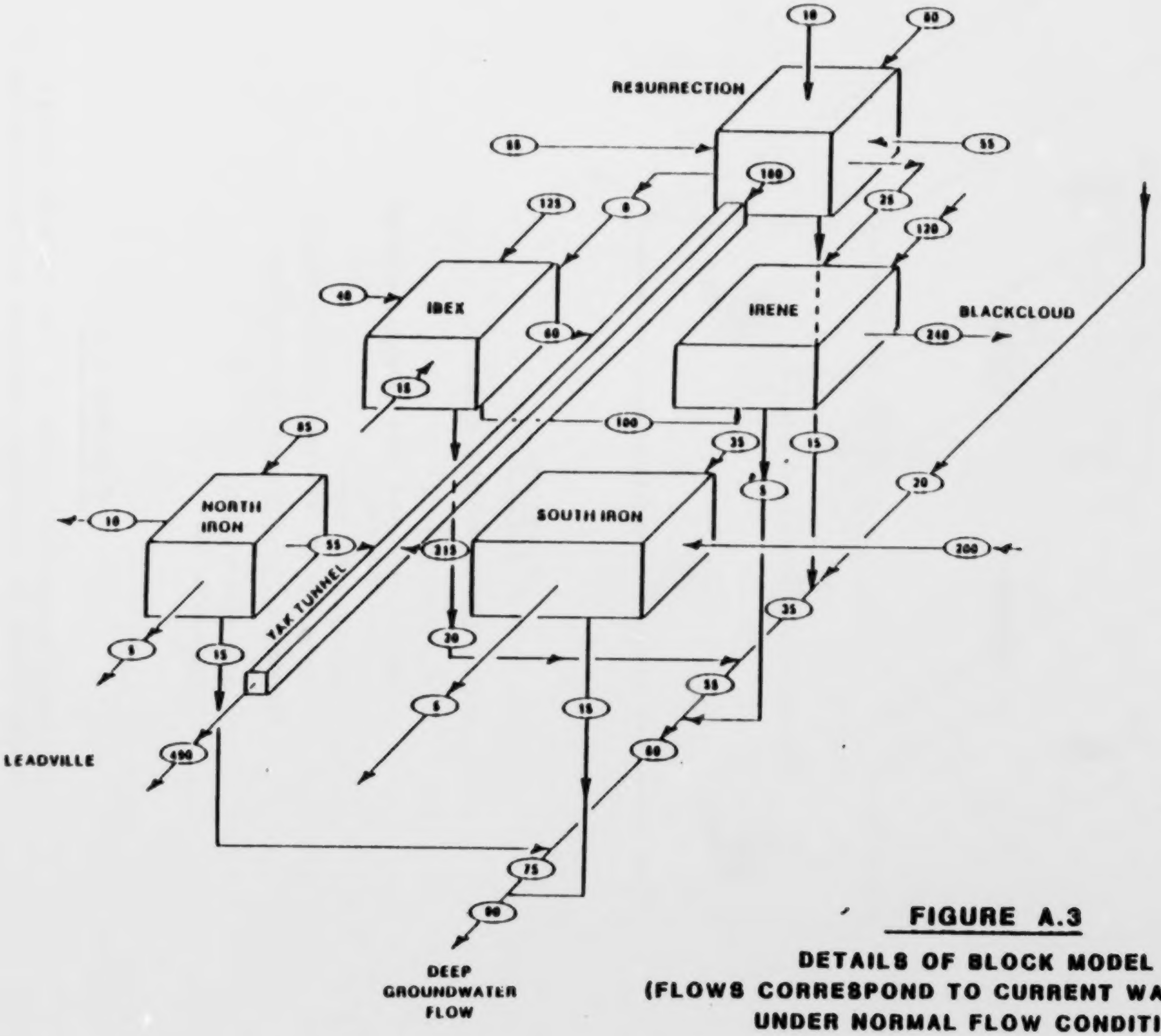

10
80
RESURRECTION
65
55
100
125
5
25
120
40
IBEX
60
IRENE
BLACKCLOUD
240
15
100
85
35
15
5
20
NORTH IRON
10
55
215
SOUTH IRON
200
YAK TUNNEL
35
5
15
20
55
5
15
60
LEADVILLE
490
75
90
DEEP GROUNDWATER FLOW

FIGURE A.3

DETAILS OF BLOCK MODEL
(FLOWS CORRESPOND TO CURRENT WATER BALANCE
UNDER NORMAL FLOW CONDITIONS IN GPM)

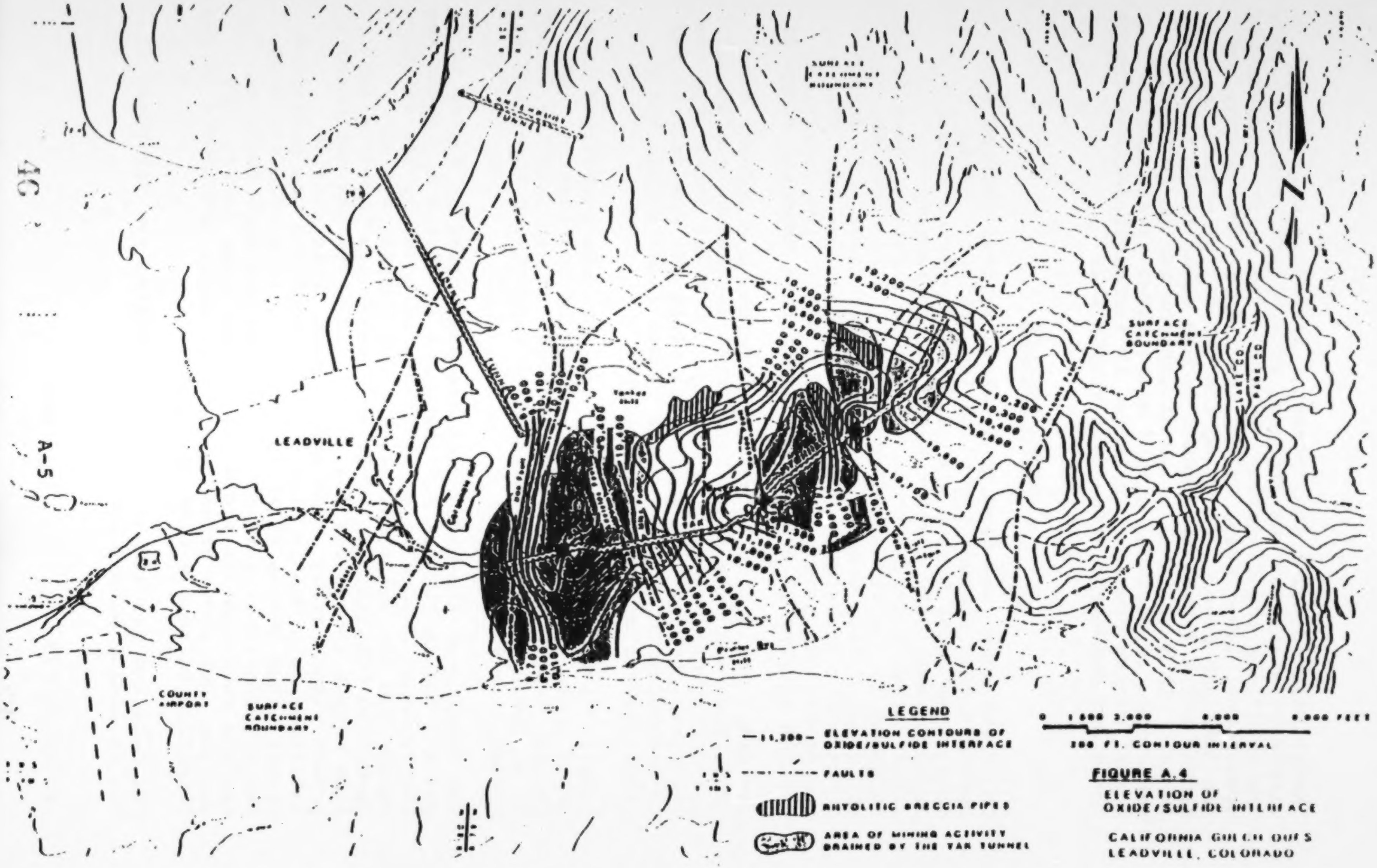

N
LAKE CO.
PARK CO.
SURFACE CATCHMENT BOUNDARY
SURFACE CATCHMENT BOUNDARY
SURFACE CATCHMENT BOUNDARY
LEADVILLE
COUNTY AIRPORT
YAK TUNNEL
10,200
10,300
LEGEND
—11,200— ELEVATION CONTOURS OF OXIDE/SULFIDE INTERFACE
FAULTS
RHYOLITIC BRECCIA PIPES
AREA OF MINING ACTIVITY DRAINED BY THE YAK TUNNEL
0 1,000 2,000 4,000 6,000 FEET
200 FT. CONTOUR INTERVAL

FIGURE A.4

ELEVATION OF
OXIDE/SULFIDE INTERFACE

CALIFORNIA GULCH OU'S
LEADVILLE, COLORADO

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4C

"Water Balance Model Compartments" in Figure A.1). Other discharge areas for the regional ground water system include the Leadville and Canterbury Tunnels, the Black Cloud mining operations, lower Evans Gulch, lower California Gulch, and the Arkansas River. Plugging the Yak Tunnel would raise ground water levels and reduce ground water flows toward the tunnel. In some cases, flow directions may be reversed. Reductions in regional ground water flows toward the Yak Tunnel mining areas are balanced by increased inflows toward the other discharge areas (see Figure A.2).

MODEL RESULTS

The block model was used to simulate typical bedrock flow during normal current hydrologic conditions. These conditions occur during the nonsnowmelt period from approximately July through March and correspond to steady-state flows. During the snowmelt period, significant recharge to the ground water occurs. It is, however, not anticipated that ground water flow directions will change during this recharge period. The normal flow simulations, therefore, adequately define ground water flow conditions for the purpose of evaluating alternative remedial measures.

The model was initially used to simulate the current flow conditions with the Black Cloud mine dewatering operations. A significant component of this ground water comes from the Yak Tunnel system. An additional model run was carried out to determine the effect on Yak Tunnel flows should Black Cloud cease its pumping operations.

Finally, the model was used to simulate the conditions that would occur when the selected remedy is implemented. As before, two model runs were performed to simulate the impact of an operating and a nonoperating Black Cloud mine dewatering system.

The results of the model runs are summarized in Tables A-1 and A-2 and in Figures A.5 through A.8. Table A-1 shows how the regional ground water flows are affected by the selected remedy and the different Black Cloud pumping system operating conditions. Table A-2 summarizes the detailed flow region around the Yak Tunnel and lists the estimated ground water levels. The approximate oxide/sulfide interface is shown in Figure A.4. Comparing the projected ground water levels shown in Table A-2 with the levels of the oxide/sulfide interface indicates how much residual sulfide rock remains above the ground water table. Any sulfide rock above ground water will still contribute to the formation of acidic mine drainage.

The detailed results of the model studies are discussed in the following subsections.

Table A-1
GROUND WATER MODEL WATER BALANCE COMPONENTS

	Yak Tunnel Model				Regional Ground Water System			
	Inflow				Inflow			
Conditions	Infiltration Q_I (1)	Interchange Q_R (2)	Total (3)=(1)+(2)	Outflow (4)	Infiltration Q_{RI} (5)	Interchange Q_R (6)	Outflow (7)=(5)+(6)	Total System Outflow (8)=(4)+(7)
Current								
Normal flow, no plugs Black Cloud Mine pumping	10	810	820	820	1,990	-810	1,180	2,000
Normal flow, no plugs Black Cloud Mine not pumping	10	770	780	780	1,990	-770	1,220	2,000
Selected Remedy								
Resurrection, Ibex, and portal plugs Black Cloud Mine pumping	10	590	600	600	1,990	-590	1,400	2,000
Resurrection, Ibex, and portal plugs Black Cloud Mine not pumping	10	335	345	345	1,990	-335	1,655	2,000

Notes:
1. All flows in gallons per minute (gpm).
2. Assume $Q_{RI} + Q_I = 2,000$ gpm.

Table A-2
SUMMARY OF GROUND WATER FLOW PROJECTIONS UNDER VARIOUS PLUGGING SCENARIOS

Scenarios	Portal Flow (gpm)	To Leadville Tunnel (gpm)	To Evans Gulch Area (gpm)	To California Gulch Area (gpm)	To Black Cloud (gpm)	To Deep Ground Water (gpm)	Flow Diverted to Other Areas Because of (gpm) Plug	Water Level Elevations in Mine Areas (steady-state, normal flow, ft msl)				
								Resurrection	Ibex	Irene	North Iron	South Iron
Current Conditions												
Normal flow, no plugs Black Cloud Mine pumping	490	10	--	10	240	70	0	10,400	10,400	10,000	10,350	10,350
Normal flow, no plugs Black Cloud Mine not pumping	675	10	--	10	--	85	40	10,400	10,400	10,600	10,350	10,350
Selected Remedy												
Resurrection, Ibex, and portal plugs Black Cloud Mine pumping	0	25	--	170	315	90	220	10,750	10,650	10,000	10,500	10,500
Resurrection, Ibex, and portal plugs Black Cloud Mine not pumping	0	25	25	170	--	125	475	10,900	10,800	10,800	10,500	10,500

Note: Yak Tunnel portal elevation is 10,333 feet (above msl).

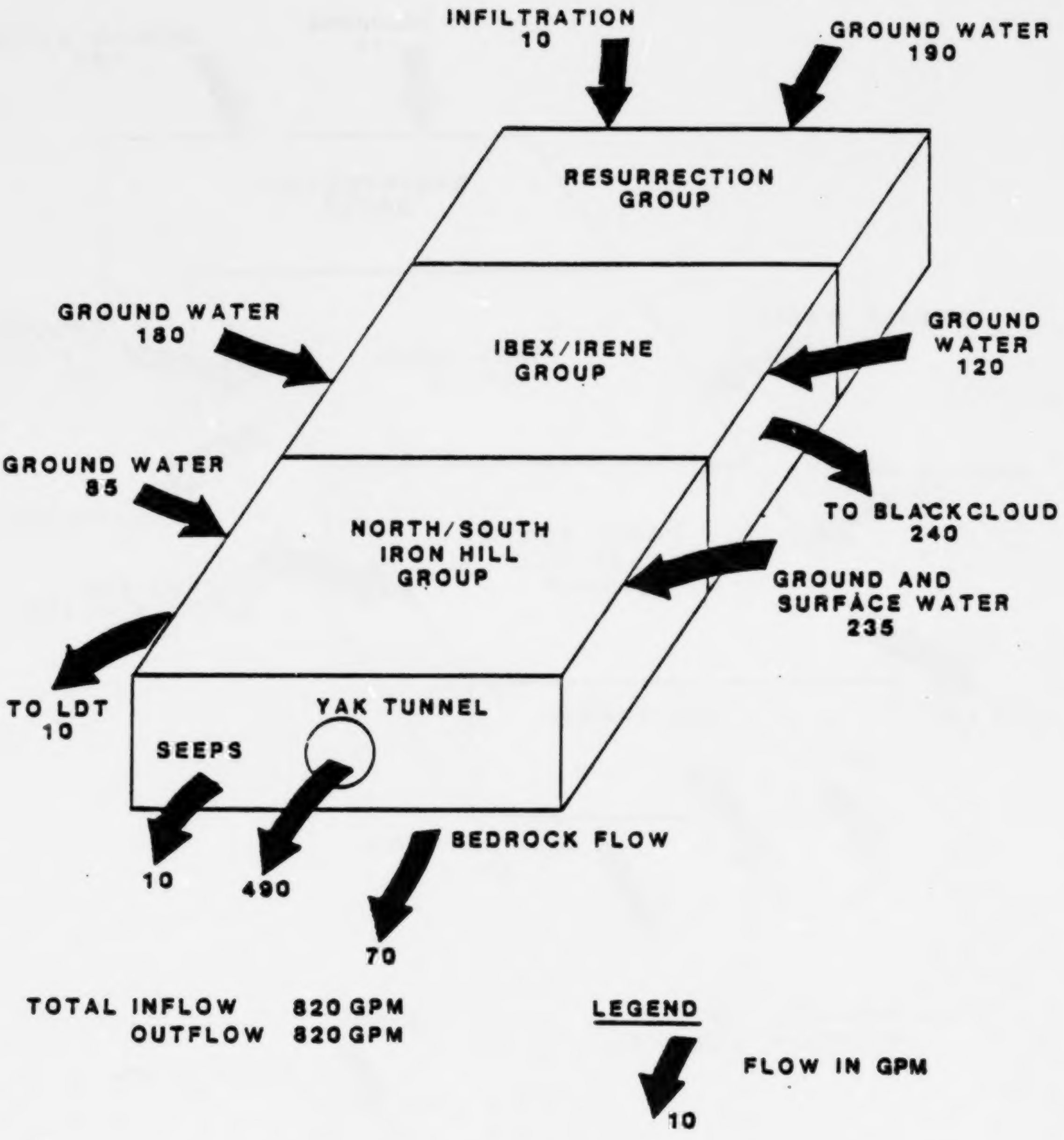
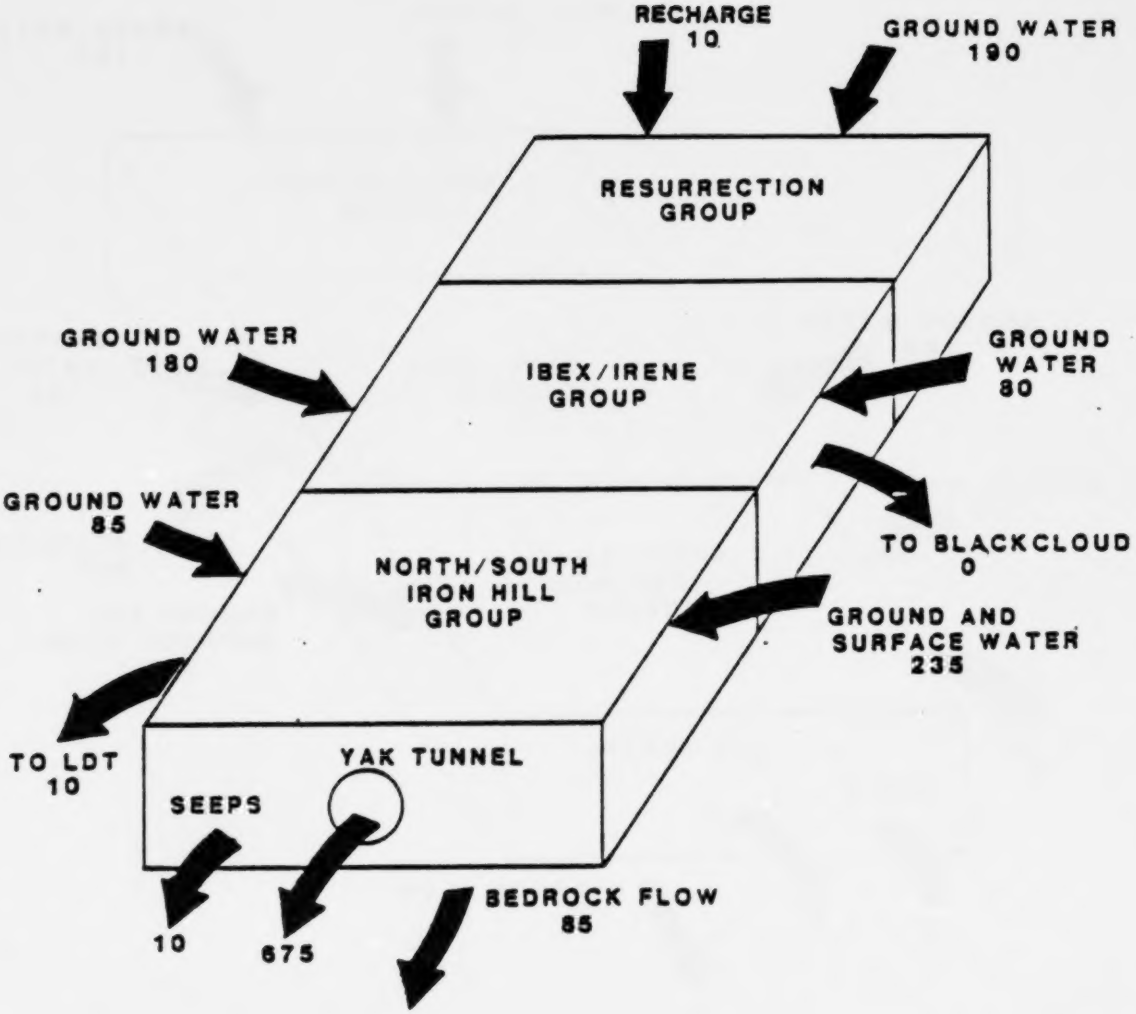

INFILTRATION
10
GROUND WATER
190
RESURRECTION GROUP
GROUND WATER
180
IBEX/IRENE GROUP
GROUND WATER
120
GROUND WATER
85
TO BLACKCLOUD
240
NORTH/SOUTH IRON HILL GROUP
GROUND AND SURFACE WATER
235
TO LDT
10
YAK TUNNEL
SEEPS
10
490
BEDROCK FLOW
70
TOTAL INFLOW 820 GPM
OUTFLOW 820 GPM
LEGEND
FLOW IN GPM
10

FIGURE A.5

NORMAL FLOW, NO PLUGS
BLACK CLOUD PUMPING


RECHARGE
10
GROUND WATER
190
RESURRECTION GROUP
GROUND WATER
180
IBEX/IRENE GROUP
GROUND WATER
80
TO BLACKCLOUD
0
GROUND WATER
85
NORTH/SOUTH IRON HILL GROUP
GROUND AND SURFACE WATER
235
TO LDT
10
YAK TUNNEL
SEEPS
10
675
BEDROCK FLOW
85

TOTAL INFLOW 780 GPM
OUTFLOW 780 GPM

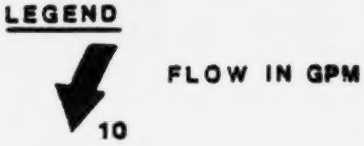

LEGEND
FLOW IN GPM
10

FIGURE A.6

NORMAL FLOW, NO PLUGS
BLACK CLOUD NOT PUMPING

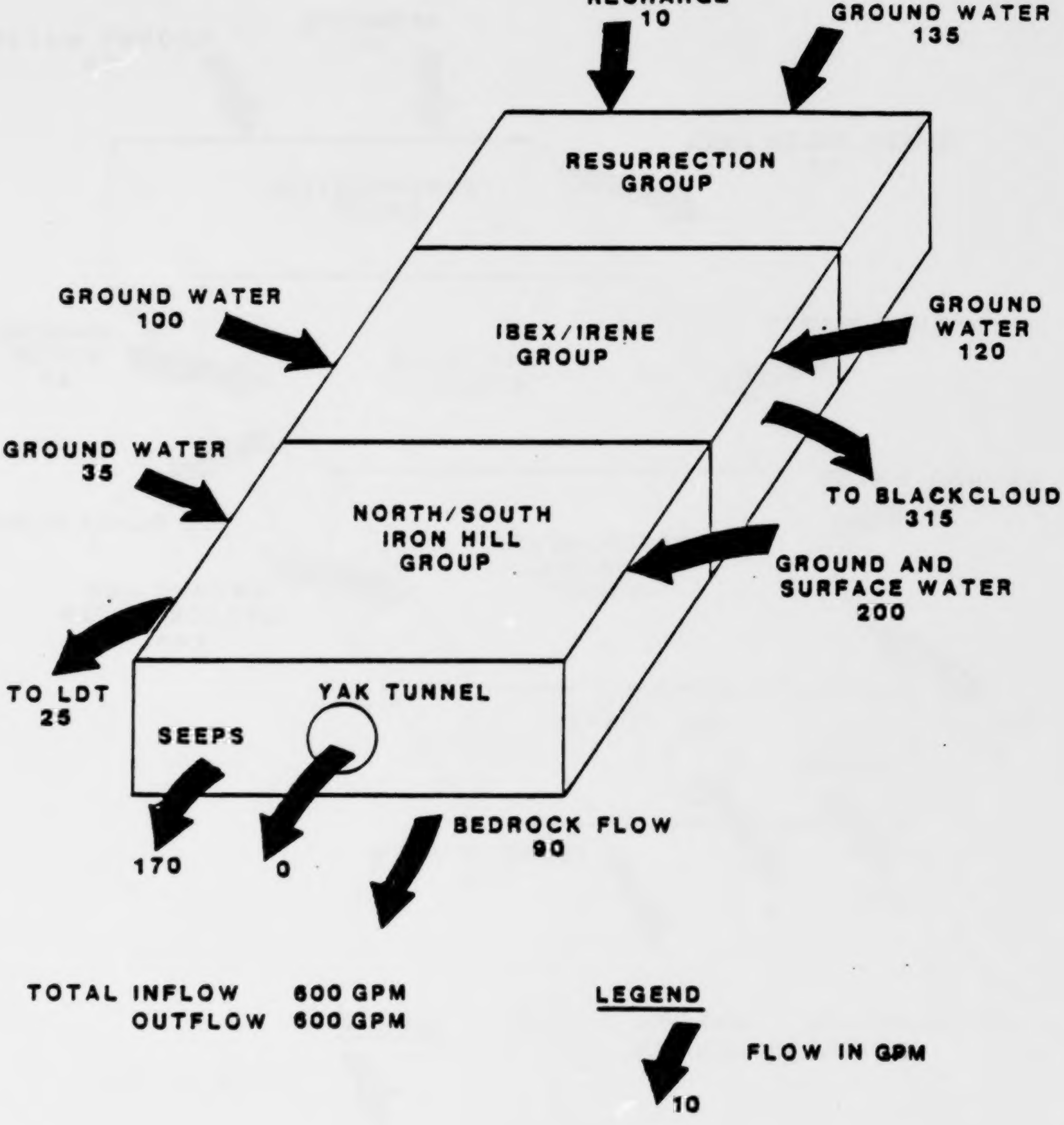

RECHARGE 10
GROUND WATER 135
RESURRECTION GROUP
GROUND WATER 100
IBEX/IRENE GROUP
GROUND WATER 120
GROUND WATER 35
TO BLACKCLOUD 315
NORTH/SOUTH IRON HILL GROUP
GROUND AND SURFACE WATER 200
TO LDT 25
YAK TUNNEL
SEEPS
170
0
BEDROCK FLOW 90
TOTAL INFLOW 600 GPM
OUTFLOW 600 GPM
LEGEND
FLOW IN GPM
10

FIGURE A.7

NORMAL FLOW, RESURRECTION, IBEX AND PORTAL PLUGS
BLACK CLOUD PUMPING

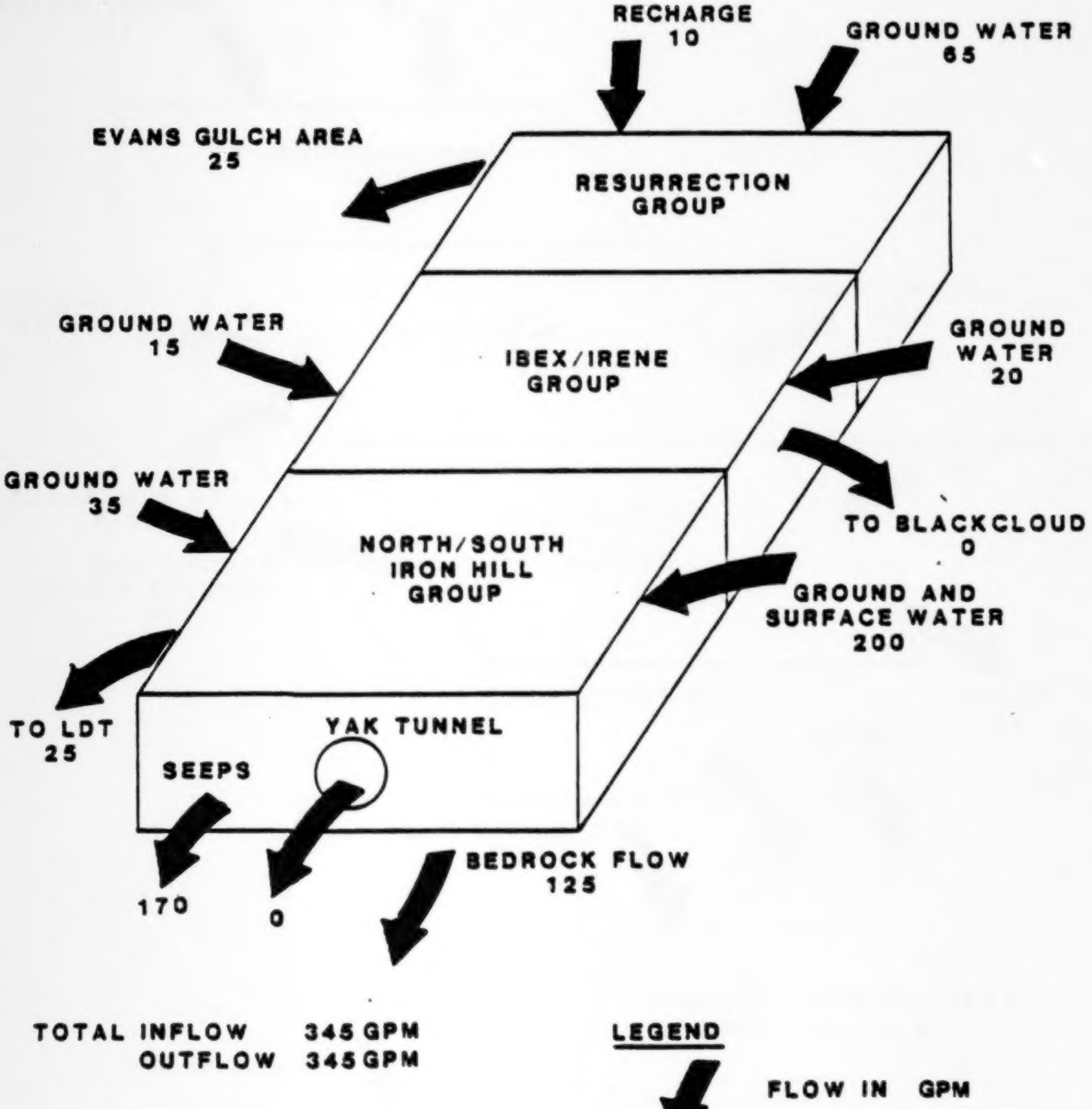

RECHARGE
10
GROUND WATER
65
EVANS GULCH AREA
25
RESURRECTION
GROUP
GROUND WATER
15
IBEX/IRENE
GROUP
GROUND
WATER
20
GROUND WATER
35
TO BLACKCLOUD
0
NORTH/SOUTH
IRON HILL
GROUP
GROUND AND
SURFACE WATER
200
TO LDT
25
YAK TUNNEL
SEEPS
170
0
BEDROCK FLOW
125
TOTAL INFLOW 345 GPM
OUTFLOW 345 GPM
LEGEND
FLOW IN GPM
10

FIGURE A.8

NORMAL FLOW, RESURRECTION, IBEX AND PORTAL PLUG
BLACK CLOUD NOT PUMPING

CURRENT CONDITIONS, BLACK CLOUD PUMPING

As shown in Figure A.5, normal base flow from the Yak Tunnel is approximately 490 gallons per minute (gpm). About 240 gpm flows toward and is removed in the Black Cloud workings. A small amount of ground water seepage, approximately 10 gpm, flows toward the Leadville Drainage Tunnel and into bedrock and alluvium along California Gulch. About 70 gpm probably flows into the deep bedrock ground water body below the Yak Tunnel.

CURRENT CONDITIONS, BLACK CLOUD NOT PUMPING

Should pumping operations at Black Cloud cease, the normal portal outflow would increase by about 185 gpm. Due to the higher water levels in the Irene area, the deep ground water flow would increase slightly to about 85 gpm (from 70 gpm) (see Figure A.6).

SELECTED REMEDY, BLACK CLOUD PUMPING

After installation of the Resurrection, Ibex, and portal plugs, Yak Tunnel portal flow will be reduced to near zero (Figure A.7). The location of the plugs is shown in Figure A.4. Water levels in the Resurrection and Ibex Groups would increase to approximately 10,750 feet and 10,650 feet mean sea level (msl), respectively. Sulfide rock would still be present above the water table and some acidic mine drainage formation would persist. The stabilized ground water level within Iron Hill Group is difficult to predict. Assuming it is around 10,500 feet above msl, then most of the sulfide rock would be inundated. Deep ground water flow would increase to approximately 90 gpm and inflow to Black Cloud to 315 gpm. Ground water seepage toward the Leadville Drainage Tunnel would increase from 10 to approximately 25 gpm. Other than a slight increase in the Leadville Drainage Tunnel flows, this is not expected to cause any noticeable ground water quality impact. Seepage toward California Gulch in the Iron Hill area would increase substantially to approximately 170 gpm.

As the ground water level rises behind the portal plug, surface seeps may develop to the west and the south of the portal area. These areas are topographically lower than the ground water levels behind the plug and contain fractured rock and, in some cases, near-surface underground mine workings. The area, therefore, is likely to offer the least amount of resistance to ground water flow. Grouting and surface stream channelization, which is expected to be part of the selected remedy, will probably have to be carried out in these critical areas.

Stream channelization will probably be required where California Gulch flows over the near-surface underground mine workings that connect to the Yak Tunnel. Grouting will probably be required along and to the west of the 10,500-foot contour. Extensive grouting may be required in the area overlying the underground mine workings immediately to the north of the Yak Tunnel portal.

In addition to the grouting program, seepage control will also be accomplished by lowering the ground water level behind the portal plug by pumping. It is anticipated that some optimum combination of pumping and grouting will ultimately be implemented. The stable ground water level behind the portal plug may then be lower than the 10,500-foot level indicated.

SELECTED REMEDY, BLACK CLOUD NOT PUMPING

When the Black Cloud mine is not pumping and the Resurrection, Ibex, and portal plugs are in place, the water levels in the Irene Group would increase significantly to approximately 10,800 feet msl, while those in the Resurrection Group would increase slightly to 10,900 feet msl. However, acidic mine drainage would likely still occur in these areas because some sulfide rocks could still be exposed. The water level in the Iron Hill Group would not be affected.

The total deep ground water seepage from all mine workings would increase to 125 gpm and an additional seepage of roughly 25 gpm from the Resurrection Group toward the Evans Gulch area would occur. Due to its small quantity, this seepage is not expected to cause any significant ground water quality deterioration in the Evans Gulch area. The monitoring network, which shows both ground water flow and quality conditions, will provide information to track this condition. The 170-gpm seepage to California Gulch would still apply and would have the potential for environmental impact as described above with all three plugs installed.

Appendix B
COST ESTIMATES

Appendix B
COST ESTIMATES

INTRODUCTION

This appendix documents the estimated capital and operating and maintenance costs for the selected remedy. The actual costs will be determined by decisions made during the design phase and if contingency measures must be implemented.

METHODS USED

Capital cost estimates were developed from approximate quantities and appropriate unit rates. For grouting, a lump sum estimate was used. Operations and maintenance (O&M) costs were developed using percentages of capital costs or quantities and unit prices for consumables such as lime and power. The capital cost unit rates and O&M percentage estimates were based on the following published information:

- o NW Mining Association (1983)
- o Peters and Timmerhaus (1980)
- o Dodge (1982)

In addition, the professional experience and judgment of the engineers involved in technical support were used. Phone interviews were also conducted with mining construction companies to obtain budget-level cost estimates for shaft construction.

Table B-1 summarizes the basis for the unit cost estimates for the various engineering components.

ASSUMPTIONS

The pumping and interim treatment system has been sized for a capacity of 300 gpm. It is assumed that the average operating flow rate will be 150 gpm. Capacities of other components are listed in Table B-2. The table also includes dimensions of key items such as channel lengths, shaft depths, and so forth. Pond closure and reclamation costs have not been included. Estimates of reagent consumption are also shown. The grouting program costs were based on typical costs associated with the construction of medium-sized dams where grouting is used to reduce seepage flow through abutments and foundations.

The monitoring program costs were based on the conceptual plan outlined in Section VI. It was assumed that no existing shafts could be used for ground water monitoring

Table B-1
BASIS FOR CAPITAL AND OPERATING COST ESTIMATES

Cost Items	Comments
Tunnel Rehabilitation	Estimate based on experience with other tunnel rehabilitation projects
Shaft and Hoist	Estimate based on discussions with mining construction companies
Ventilation and Lighting	Estimate based on experience with other underground projects
Concrete Channel and Flood Diversion	Estimate based on a nominal 10-foot channel width and concrete at $\$300/\text{yd}^3$ including excavation, forming, concrete, finishing, and backfill where appropriate
Shaft Sealing	Estimates based on experience with shaft sealing
Monitoring System	Estimates based on similar experience on other projects
Water Treatment System	Estimate based on similar experience on other projects
Piping and Miscellaneous	Lump sum estimate
Lime Equipment	Lump sum estimate
Fence	Cost based on 1982 Dodge Cost Handbook and adjusted for inflation
Grouting	Order-of-magnitude estimate based on typical costs for foundation grouting at embankment dams
Power Supply	Estimate based on experience with other projects
Maintenance Costs	Based on industry operating studies from Peters and Timmerhaus
Operating Supplies	Based on industry operating standards from Peters and Timmerhaus
Operating Life	Ten-year life for mechanical parts of treatment facilities is assumed. All civil (concrete and soil) structures assumed to have a 50-year life

Table B-2
COST ESTIMATES FOR SELECTED REMEDY

SYSTEM CRITERIA

MAXIMUM CAPACITY OF PUMP/TREATMENT	300	GPM
LIME CONSUMPTION	2,300	LB/DAY
POWER REQUIREMENT	500	HP
AVERAGE FLOW PUMPED/TREATED	150	GPM
POWER REQUIREMENT	250	HP
LIME CONSUMPTION	1,150	LB/DAY
PERIOD OF MONITORING	10	YEARS
	50,000THEREAFTER	IN PERPETUITY
PERIOD OF TREATMENT (MAX.)	10	YEARS

CAPITAL COST					SUBTOTAL	CIVIL	ELEC./ MECHANICAL	FRONT END	ANNUAL OPERATION & MAINTENANCE COSTS			SUBTOTAL
TUNNEL PLUGGING					$1,781,100							$23,500
PLUGS	3	PLUG	$116,200	348,600				348,600				
TEMP. TUNNEL REHAB	3,500	FT	$135	472,500				472,500				
VENTILATION	LUMP SUM			25,000				25,000				
LIGHTING	LUMP SUM			10,000				10,000				
SHAFT CONSTRUCTION	350	FT	$1,500	525,000		525,000			MAINTENANCE	2.00%	10,500	
HOIST	LUMP SUM			200,000			200,000		MAINTENANCE	4.00%	8,000	
VENTILATION	LUMP SUM			75,000			75,000		MAINTENANCE	4.00%	3,000	
LIGHTING	LUMP SUM			25,000			25,000		MAINTENANCE	4.00%	1,000	
ACCESS ROAD	LUMP SUM			100,000		100,000			MAINTENANCE	1.00%	1,000	
SURFACE WATER CONTROL MEASURES					$2,630,000							$23,150
CONCRETE CHANNEL	1,500	FT	$300	450,000		450,000			MAINTENANCE	0.50%	2,250	
SHAFT SEALS	6	SHAFTS	$30,000	180,000		180,000			MAINTENANCE	0.50%	900	
GROUTING	MAX. AS REQUIRED			2,000,000				2,000,000	MAINTENANCE	1.00%	20,000	
MONITOR SYSTEM					$1,800,000							$266,250
MONITOR WELLS	35	450 FT	$100 PER FT	1,575,000				1,575,000	MAINTENANCE	5.00%	78,750	
SAMPLING PUMPS	35	@	$5,000	175,000				175,000	MAINTENANCE	10.00%	17,500	
FLUMES,WEIRS,ETC.	LUMP SUM			50,000				50,000	MAINTENANCE	5.00%	2,500	
									SAMPLING TECHNICIANS		75,000	
									CHEMICAL ANALYSES 250	$250	62,500	
									REMOTE SENSING		20,000	
									EXPENSES		10,000	
WATER COLLECTION AND TREATMENT					$1,672,302							$170,907
PUMP SYSTEM												
PUMP	98	HP @	$100	9,802			9,802		MAINTENANCE	5.00%	490	
PIPING	2,000	FT @	$50	100,000			100,000		MAINTENANCE	3.00%	3,000	
SURGE/TREATMENT PONDS												
PONDS	3.9	ACRES	$250,000	975,000				975,000	MAINTENANCE	1.00%	9,750	
UNDERDRAIN	3.9	ACRES	$25,000	97,500				97,500	MAINTENANCE	1.00%	975	
FLOOD DIVERSION	300	FT	$400	120,000				120,000	MAINTENANCE	2.00%	2,400	
PIPING,MISC.	LUMP SUM			25,000				25,000	MAINTENANCE	3.00%	750	
LIME EQUIPMENT	LUMP SUM			85,000				85,000	MAINTENANCE	3.00%	2,550	
FENCE	2,000	FT	$30	60,000				60,000	MAINTENANCE	5.00%	3,000	
FLOC SYSTEM	LUMP SUM			15,000				15,000	MAINTENANCE	5.00%	750	
									LIME	$35.00 PER TON	7,344	
POWER SUPPLY												
SUBSTATION	1,000	KV @	$35	35,000			35,000		MAINTENANCE	5.00%	1,750	
DISTRIBUTION AND CONTROL	500	HP @	$300	150,000			150,000		MAINTENANCE	5.00%	7,500	
									POWER @	8.00 C/KWH	130,647	
SUBTOTAL					$7,883,402	1,255,000	594,802	6,033,600				$460,307
ADD-ON ITEMS	SCOPE AND BID		35.00%		2,759,191	439,250	208,181	2,111,760	ADMINISTRAT	10.00%	46,031	
	ADMIN./LEGAL/SAFET		2.00%		157,668	25,100	11,896	120,672	INSURANCE,T AND LICENSE	2.00%	9,206	
	CONSTRUCTION SERVI		10.00%		788,340	125,500	59,480	603,360	CONTINGENCY	15.00%	69,046	
	STARTUP		5.00%		394,170	62,750	29,740	301,680				
TOTAL					$11,982,770	1,907,600	904,098	9,171,072				$460,307

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and that approximately 50 percent of the identified well locations would require two wells to monitor conditions in different ground water bodies. It was also assumed that the full program would be operated for the initial 10-year period and that the level of effort thereafter would be reduced by 50 percent since operating experience with the system would have been established.

ACCURACY OF ESTIMATES

With the exception of the costs associated with the monitoring and the grouting programs, the cost estimates are generally within a -30 percent to +50 percent range of accuracy. Due to the lack of site-specific geologic and geohydrologic data, the costs associated with the monitoring and grouting should only be regarded as order-of-magnitude estimates.

COMPARISON WITH COST FIGURES IN FS

The basis of this estimate is generally similar to that developed in the FS. Exceptions primarily include the grouting and monitoring programs outlined above. The costs associated with the surge ponds have also been increased over those presented in the FS. The ponds used in the selected remedy incorporate a double liner and leachate collection system. Since the ponds are deeper than the "collection" ponds referred to in the FS, they are also equipped with an underdrain to minimize uplift pressure on the liner caused by ground water. The capital costs and annual O&M costs are shown in Table B-2. The present worth analysis at 10 percent, 5 percent and 3 percent discount rates are shown in Table B-3.

Table B-3
PRESENT WORTH ANALYSIS AT VARIOUS DISCOUNT RATES

PARAMETERS												
DISCOUNT RATE				10.00%			5.00%			3.00%		
				SINKING FUND FACTORS	PRESENT VALUE OF A LUMP SUM		SINKING FUND FACTORS	PRESENT VALUE OF A LUMP SUM		SINKING FUN FACTORS	PRESENT VALUE OF A LUMP SUM	
ECONOMIC LIVES												
CIVIL		50.00	YRS	0.00086			0.00478			0.00887		
MECHANICAL/ELECTRICAL		15.00	YRS	0.03147			0.04634			0.05377		
MONITORING		10.00	YRS	0.06275	0.38554		0.07950	0.61391		0.08723	0.74409	
PRESENT VALUE COSTS	TOTAL					$ 17,716,363			$23,260,235			$ 30,684,6
	CAPITAL COSTS				$12,283,714			$ 13,002,972			$ 14,166,841	
	ORIGINAL			11,982,770			11,982,770			11,982,770		
	REPLACEMENT	CIVIL		16,390			182,242			563,727		
		ELEC/MECH		284,554			837,960			1,620,343		
	ANNUAL COSTS				$ 5,332,649			$10,057,263			$ 16,184,428	
	O&M			5,845,903			11,691,807			19,486,344		
	CREDIT FOR REDUCED MONITORING			513,255			1,634,544			3,301,917		
	5.00 YEAR REVIEW @	$50,000		100,000	$100,000		200,000	$200,000		333,333	$ 333,333	

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Dodge. 1982 Data from Dodge--Guide to Heavy Construction Costs. McGraw-Hill. 1982.

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Peters & Timmerhaus. Plant Design and Economics for Chemical Engineers. 1980.

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Appendix C
EVALUATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Appendix C
EVALUATION OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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I. INTRODUCTION

EPA and the State of Colorado have identified chemical-specific, location-specific, and action-specific applicable or relevant and appropriate requirements ("ARARs") for the Yak Tunnel operable unit of the California Gulch site. This Appendix describes the ARARs identified and how they relate to the selected remedy.

II. CHEMICAL-SPECIFIC REQUIREMENTS

Chemical-specific ARARs set health or risk-based concentration limits in various environmental media or discharge limitations for specific hazardous substances, pollutants, and contaminants. These requirements generally set protective levels for the chemicals of concern in designated media, or else indicate an acceptable level of emission or discharge of such substances. EPA and the State have identified ARARs under the Safe Drinking Water Act, Colorado safe drinking water authorities, the Clean Water Act, and the Colorado Water Quality Control Act. These are described below.

A. Maximum Contaminant Levels for Drinking Water

The Federal Safe Drinking Water Act, 42 U.S.C. section 300g, and Colorado drinking water authorities, Colo. Rev. Stat. section 25-1-107(x)-(y), provide for the establishment of drinking water standards for public water systems. These standards are "applicable" only to public water systems as defined by the acts and regulations. However, they may be considered "relevant and appropriate" as ARARs for potential ground water and surface water exposure via drinking water. U.S. EPA, Superfund Public Health Evaluation Manual (Oct. 1986). Because of the connection between surface water and ground water in the lower California Gulch shallow alluvial system which is an existing or potential source of drinking water, drinking water standards are considered ARARs for surface water in California Gulch.

The Safe Drinking Water Act "maximum contaminant levels" or "MCLs" for inorganic chemicals are considered ARARs. MCLs are enforceable standards establishing permissible levels of contaminants in drinking water. See 40 C.F.R. section 141.2(c) (1987). These standards are health-based, but have an economic component. See 42 U.S.C. section 1401(1)(C). The MCLs currently established for inorganic chemicals are listed in Table 1. The Federal and State MCLs for these substances are identical. See Colorado Primary Drinking Water Regulations, 5 Colo. Code Regs. 1003-1 (1981).

The Safe Drinking Water Act also provides for establishment of secondary MCLs. These are designed to "control contaminants

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Table 1. Numeric Inorganic Chemical-specific ARARs (ppb)

	MCLs[1]	Ambient Water Quality Criteria[2]	
		Acute[3]	Chronic[4]
Arsenic	50	360	190
Barium	1000		
Cadmium	10	3.9**	1.1**
Chromium	50		
III		1700**	210**
VI		16	11
Copper	1000*	18**	12**
Cyanide		22	5.2
Fluoride	2000*		
Iron	300*		1000
Lead	50	82**	3.2**
Manganese	50*		
Mercury	2	2.4	0.012
Nickel		1400**	160**
Nitrate	10000		
Selenium	10	20	5.0
Silver	50	4.1**	
Sulfate	250000*		
Zinc	5000*	120**	110**

---

* Secondary Maximum Contaminant Levels

** Hardness dependent. Value set at hardness of 100 mg/L $CaCO_3$.

[1] Maximum Contaminant Levels. These include National Primary Drinking Water Regulations, 40 C.F.R. section 141.11(b) (1987)

Table 1 (cont.)

(maximum contaminant levels for inorganic chemicals), and National Secondary Drinking Water Regulations, 40 C.F.R. section 143.3 (1987) (secondary maximum contaminant levels for inorganic chemcials). The State maximum contaminant levels are identical to the Federal levels. See Colorado Primary Drinking Water Regulations, 5 Colo. Code Regs. 1003-1 (1981).

2. Ambient Water Quality Criteria values for freshwater aquatic life are taken from EPA's "Quality Criteria for Water 1986" (May 1986) (and Update #2 dated May 1, 1987) and "Ambient Water Quality Criteria for Selenium-1987 (Sept. 1987).

3. These criteria are the one-hour average concentrations that are not to be exceeded more than once every three years on average.

4. These criteria are the four-day average concentrations that are not to be exceeded more than once every three years on average.

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in drinking water that primarily affect the aesthetic qualities relating to public acceptance of drinking water." 40 C.F.R. section 143.1 (1987). The regulations note that secondary MCLs "in the judgment of the Administrator [of EPA] are requisite to protect the public welfare." 40 C.F.R. section 143.2(f). The Federal secondary MCLs for inorganic chemicals are listed in Table 1. In addition to those listed, there are secondary MCLs for chloride, color, corrosivity, fluoride, foaming agents, odor, pH, and total dissolved solids. The State of Colorado has not promulgated secondary MCLs.

EPA anticipates that the selected remedy will not achieve a degree of cleanup in lower California Gulch surface water that attains primary and secondary MCLs. The Phase I RI identified numerous sources that contribute to metals loadings in lower California Gulch. These include mine wastes, tailings, and slag in the California Gulch drainage basin and in its tributaries. The tunnel plugging and interim treatment facility components of the selected remedy will achieve substantial reductions in the contribution of the Yak Tunnel to metals loadings in California Gulch. However, this operable unit is not the total remedy for the site. It will be necessary to develop and evaluate additional source control measures, including one or more permanent treatment facilities, to attain or exceed drinking water ARARs for specific metals.

B. Federal Ambient Water Quality Criteria

Section 304(a) of the Clean Water Act, 33 U.S.C. section 1314(a), requires EPA to develop ambient water quality criteria related to protection of human health and aquatic life. EPA has developed criteria for numerous substances. The Federal water quality criteria are not directly enforceable and are therefore not "applicable" to the cleanup. However, under SARA and EPA guidance, they may be considered "relevant and appropriate" under the circumstances of the release or threatened release. See Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements, 52 Fed. Reg. 32,496, 32,499 (1987).

Under section 121(d)(2)(A) of SARA, the remedy selected must "require a level or standard of control which at least attains ... water quality criteria established under section 304 or 303 of the Clean Water Act, where such ... criteria are relevant and appropriate under the circumstances of the release or threatened release." SARA further provides that "[i]n determining whether or not any water quality criteria under the Clean Water Act is relevant and appropriate under the circumstances of the release, [EPA] shall consider the designated or potential use of the surface water or groundwater, the environmental media affected, the purposes for which such criteria were developed, and the latest information available." 42 U.S.C. section 9621(d)(2)(B)(i).

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EPA has determined that the ambient water quality criteria for acute and chronic toxicity to freshwater aquatic life are relevant and appropriate as ARARs for surface water in California Gulch and the segment of the Arkansas River from the confluence with California Gulch to Lake Fork. The values for the metals of concern are listed in Table 1. EPA's determination is based on the following considerations.

1. Existing or Potential Uses

The State of Colorado has classified the stretch of the Arkansas River from immediately above California Gulch to Lake Fork for uses including "Class 1 cold water aquatic life." 5 Colo. Code Regs. 1002-8, p. 10.41. Section 3.1.13(1)(c)(i) of the State regulations entitled "The Basic Standards and Methodologies" defines this use as follows:

> These waters provide, or could provide, a habitat consisting of water quality levels and other considerations such as flow and streambed characteristics which do or could protect and maintain a wide variety of cold water biota, including sensitive species. Cold water biota are considered to be life forms, including trout, in water where temperatures do not normally exceed 20 [degrees centigrade].

The Federal water quality criteria for freshwater aquatic life are consistent with this use classification.

California Gulch has not been classified for particular uses. However, section 3.1.9(2) of The Basic Standards and Methodologies states that "[e]ffluent flows which reach a classified body of water, even though the discharge point is to water not yet classified, must be of a quality which will not cause the standards of the classified water to be violated." 5 Colo. Code Regs. 1002-8. The federal water criteria are consistent with this regulation. EPA plans to conduct a use attainability analysis of California Gulch to determine whether it would be appropriate to refine this cleanup goal in a subsequent operable unit.

2. Environmental Media Affected

Based on the findings of the Phase I RI, the environmental media affected by the releases and threatened releases from the Yak Tunnel include surface waters in California Gulch and the Arkansas River. The selected remedy includes discharge of treated effluent into California Gulch surface water. Under Section 3 of the FS, existing or potential aquatic life in

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California Gulch and the Arkansas River can be identified as receptors of contamination from the Yak Tunnel.

3. Purposes of the Criteria

The water quality criteria for acute and chronic toxicity to freshwater aquatic life were developed to protect freshwater organisms and their uses. These criteria are based on an evaluation of toxicity studies relating to species similar to those which are or could be present in the Arkansas River or California Gulch, to the extent that physical habitat requirements are met.

4. Latest Information Available

EPA has relied on the latest criteria documents available in making the determination that federal water quality criteria are relevant and appropriate under the circumstances of the release from the Yak Tunnel. See Quality Criteria for Water 1986 (May 1986 and Update No. 2, dated May 1, 1987) and Ambient Water Quality Criteria for Selenium--1987 (September 1987).

EPA has also developed ambient water quality criteria for protection of human health. For most chemicals, there are human health criteria for two different exposure pathways: ingestion of aquatic organisms and ingestion of both aquatic organisms and drinking water. EPA is still formulating a position with respect to the use of ambient water quality criteria for protection of human health. See 52 Fed. Reg. 32,499 (1987). EPA will evaluate the use of these criteria in a subsequent operable unit.

EPA anticipates that the selected remedy will not achieve a level or standard of control that meets water quality criteria in the California Gulch nor in the Arkansas River. As discussed above, there are numerous sources of metals loadings to California Gulch that will not be addressed as part of this operable unit. In addition, as discussed in Section III of this ROD, the Arkansas River exceeds the fresh water aquatic life water quality criteria for copper and zinc above the California Gulch confluence. To the extent that other sources can be addressed under CERCLA, it will be necessary to develop and evaluate alternatives for remedial action in subsequent operable units that will attain or exceed ARARs to protect aquatic life. In addition, EPA and the State are now conducting further work on standards and cleanup for the Arkansas River. EPA will re-evaluate the appropriateness of the ambient water quality criteria for the Arkansas River in a subsequent operable unit.

C. State Water Quality Standards

Section 303 of the Clean Water Act, 33 U.S.C. section 1313, provides for promulgation of water quality standards by the

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States. The standards consist of designated uses of water and water quality criteria based on the designated uses. 40 C.F.R. section 131.3(i). The criteria are "elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports a particular use." 40 C.F.R. section 131.3(b).

As discussed above, the State of Colorado has not developed a use classification for California Gulch. However, the State has classified the segment of the Arkansas River from immediately above California Gulch to Lake Fork for class 1 cold water aquatic life, secondary contact recreation, and agricultural uses. The aquatic life classification was discussed earlier. Section 3.1.13 of The Basic Standards and Methodologies defines the other two uses as follows:

> 1. Secondary Contact (Class 2) Recreation
>
> These surface waters are suitable or intended to become suitable for recreational uses on or about the water which are not included in the primary contact subcategory. (Primary contact uses include prolonged and intimate contact with the body or for recreational activities when ingestion of small quantities of water is likely to occur.)
>
> 2. Agriculture
>
> These waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock.

5 Colo. Code Regs. 1002-8.

The State has also identified the "basic standards" portion of The Basic Standards and Methodologies as an ARAR for the Yak Tunnel operable unit. See 5 Colo. Code Regs. 1002-8. Section 3.1.11 of these regulations establishes basic standards applicable to all waters of the State. The key portions of these standards for the Yak Tunnel operable unit state:

> Substances attributable to human-induced discharges ... shall not be introduced into waters of the State:

(a) which can settle to form bottom deposits detrimental to the beneficial uses. Deposits are stream bottom buildup of materials which include but are not limited to anaerobic sludges, mine slurry or tailings, silt, or mud; or
(b) which form floating debris, scum, or other surface materials sufficient to harm existing beneficial uses; or

(c) which produce color, odor, or other conditions in such a degree as to create a nuisance or harm existing beneficial uses or impart any undesirable taste to significant edible aquatic species or to the water; or

(d) in amounts, concentrations, or combinations which are harmful to the beneficial uses or toxic to humans, animals, plants, or aquatic life; or

(e) in amounts, concentrations, or combination which produce a predominance of undesirable aquatic life; or

(f) in concentrations which cause a film on the surface or produce a deposit on shorelines.

In addition to these "basic standards," the State of Colorado has established numeric standards for the segment of the Arkansas River between California Gulch and Lake Fork. The State did not identify these numeric standards as ARARs because, as the State noted, the current stream standards for the Arkansas River take into account the pollution from California Gulch and are not protective of aquatic life.

The basic standards will apply to discharge of treated effluent from the interim treatment facility component of the selected remedy. EPA anticipates that the interim treatment facility will not attain section 3.1.11(d) of the basic standards.

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D. Antidegradation Standard

The State of Colorado has also identified its antidegradation standard as an ARAR for the Yak Tunnel operable unit. Section 3.1.8 of The Basic Standards and Methodologies, 5 Colo. Code Regs. 1002-8, provides:

> Existing uses shall be maintained as required by state and federal law. No further water quality degradation is allowable which would interfere with or become injurious to existing uses.

Under section 3.1.3, the antidegradation standard applies to all waters of the State.

State regulations do not define the term "existing uses". Under Federal regulations, existing uses are defined as "uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." 40 C.F.R. section 131.10.

The selected remedy will meet this requirement and will in fact substantially reduce the current metals loadings in California Gulch.

III. LOCATION-SPECIFIC REQUIREMENTS

Location-specific requirements set restrictions on activities depending on the characteristics of a site or its immediate environs and may thus limit the conduct of activities in particular locations. The selected remedy includes activities potentially affecting historical resources, streams, floodplains, and wetlands. Therefore, the National Historic Preservation Act, Archeological and Historic Preservation Act, Fish and Wildlife Coordination Act, Clean Water Act, Executive Order on Floodplain Management, Federal and State waste management regulations, and the Executive Order on Protection of Wetlands establish requirements which have been identified as ARARs. In the remedial design phase, EPA will further refine the location and design of the remedial action components. To the extent that the remedial action will affect historical resources, streams, floodplains, or wetlands, EPA will ensure that all location-specific requirements are met.

A. National Historic Preservation Act

The National Historic Preservation Act, 16 U.S.C. section 470, requires Federal agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register of Historic

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Places. According to the Department of the Interior, California Gulch and the Yak Tunnel lie within the Leadville National Historic District/National Historic Landmark, and the Yak Tunnel is significant because of its historical association with mining engineering in the 19th and 20th centuries. To minimize adverse effects from implementation of the selected remedy, EPA will follow the procedures for protection of historic properties set forth in Executive Order 11,593 entitled "Protection and Enhancement of the Cultural Environment" and in 36 C.F.R. Part 800, 36 C.F.R. Part 63, and 40 C.F.R section 6.301(c).

B. Archeological and Historic Preservation Act

The Archeological and Historic Preservation Act, 16 U.S.C. section 469, establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program. If EPA finds or is notified by an appropriate historical or archeological authority that its activities may cause irreparable loss or destruction of significant scientific, prehistorical, historical, or archeological data, EPA will follow the procedures set forth in the statute and in 40 C.F.R. section 6.301(c) to provide for data recovery and preservation activities.

C. Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act, 16 U.S.C. sections 661-666, requires Federal agencies involved in actions that will result in the control or structural modification of any natural stream or body of water, for any purpose, to take action to protect the fish and wildlife resources which may be affected by the action. The tunnel plugging component of the selected remedy will modify streamflow and the surface water diversions and construction of the surge ponds may involve work in or affecting California Gulch. EPA will therefore consult with the U.S. Fish and Wildlife Service and the Colorado Department of Natural Resources to ascertain the means and measures necessary to mitigate, prevent and compensate for project-related losses of wildlife resources and to enhance the resources. EPA received and responded to comments on the FS alternatives and the proposed plan from both the Department of Interior and the State of Colorado. In addition, the State has been consulted on the Record of Decision. During remedial design, EPA will undertake further consultation to meet the requirements of this statute.

D. Clean Water Act (Section 404)

Section 404 of the Clean Water Act, 33 U.S.C. section 1344, requires permits for discharge of dredged or fill material into navigable waters. Section 502(7) of the Act defines "navigable waters" as "waters of the United States including the territorial seas." Under 33 C.F.R. Part 328, "waters of the United States" are defined for the purposes of section 404. The definition is extremely broad and covers streams, including intermittent streams. See 33 C.F.R. section 328.3(a). The term "fill material" includes "any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a water body." 33 C.F.R. section 323.2(e). The "discharge of fill material" means the addition of fill material into waters of the United States. 33 C.F.R. section 323.2(f).

Activities associated with the selected remedy could trigger Section 404 requirements. California Gulch falls within the definition of "waters of the United States." Components of the selected remedy, including construction of surge ponds, the surface water diversions, and road construction are likely to involve some discharge of material into California Gulch. Under section 121(e) of SARA, no Federal permits are required. In addition, the selected remedy falls within the definition of activities covered by the "nationwide permits" regulations. Under 33 C.F.R. section 330.5, specified activities are permitted, provided that certain conditions are met. This provision covers "[s]tructures, work, and discharges for the containment and cleanup of oil and hazardous substances which are subject to the National Oil and Hazardous Substances Pollution Contingency Plan, (40 CFR Part 300) ...." 33 C.F.R. section 330.5(a)(20).

Even though the permit application process need not be followed, both consultation and substantive requirements will be followed during the remedial design phase. Under 33 C.F.R. section 330.5(a)(20), a nationwide permit is available only if "the Regional Response Team which is activated under the [National Contingency] Plan concurs with the proposed containment and cleanup action." EPA will consult with the Regional Response Team during the design phase. Although no permit will be obtained, all substantive requirements will be met. These include substantive conditions set forth in 33 C.F.R. section 330.5(b), the management practices outlined in 33 C.F.R. section 330.6, the requirements governing road construction activities in 33 C.F.R. section 323.4(a)(6), and the section 404(b)(1) guidelines set forth in 40 C.F.R. Part 230. In addition, the policies discussed in 33 C.F.R. section 320.4 will be considered.

E. Executive Order on Floodplain Management

The Executive Order on Floodplain Management, Exec. Order No. 11,988, requires Federal agencies to evaluate the potential effects of actions they may take place in a floodplain to avoid, to the extent possible, adverse effects associated with direct and indirect development of a floodplain. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. section 6.302(b) and Appendix A. In addition, EPA has developed guidance

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entitled "Policy on Floodplains and Wetlands Assessments for CERCLA Actions," dated August 6, 1985.

Pursuant to regulations and guidance, EPA determined that remedies considered for the Yak Tunnel operable unit could affect the 100-year floodplain along California Gulch. Therefore, EPA identified and evaluated the floodplain as part of the Phase I RI and considered floodplain issues associated with various alternatives in the FS. EPA provided for public review of the floodplain assessment through the public notice and comment period on the Phase I RI and the FS. Several components of the selected remedy may affect the floodplain in upper California Gulch and near the Yak Tunnel. These are the surface water diversions and possibly construction of the surge ponds. The Statement of Findings contained in Appendix D of this ROD documents EPA's decisionmaking regarding floodplains.

F. Federal and State Waste Management Regulations

Both Federal and State solid and hazardous waste statutes have requirements pertaining to location of facilities in floodplain areas. The selected remedy may involve interim storage and disposal of excavated soils and waste treatment plant sludge. To the extent that the remedy involves storage or disposal of solid wastes, the Federal and State requirements governing siting and operation of facilities in the floodplain will be met. See 40 C.F.R. section 257.3-1 and 6 Colo. Code Regs. 1007-2, section 4.1.2. Disposal of excavated material which meets the definition of hazardous waste under 40 C.F.R. section 261.21-.24 must meet the requirements set forth in 40 C.F.R. section 264.18(b).

G. Executive Order on Protection of Wetlands

The Executive Order on Protection of Wetlands, Exec. Order No. 11,990, requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. EPA's regulations to implement this Executive Order are set forth in 40 C.F.R. section 6.302(a) and Appendix A. In addition, EPA has developed guidance entitled "Policy on Floodplains and Wetlands Assessments for CERCLA Actions," dated August 6, 1985.

EPA has identified potential wetland areas along lower California Gulch based on a review of aerial photographs. The potential wetlands are shown in Figure 2-6 of the Phase I RI report. EPA subsequently conducted a field inspection and determined that there are areas classified as wetlands. The decrease in California Gulch surface water flow resulting from tunnel plugging may reduce flow to these wetlands. Therefore, EPA has determined that there may be effects on wetlands, and

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this requirement is an ARAR. The Statement of Findings contained in Appendix D of this ROD documents EPA's decision-making regarding wetlands.

IV. ACTION-SPECIFIC REQUIREMENTS

Performance, design, and other action-specific requirements set controls or restrictions on particular kinds of activities related to management of hazardous substances, pollutants, or contaminants. These requirements are triggered not by the specific chemicals present at a site but rather by the particular remedial activities that are selected to accomplish a remedy. This section describes the action-specific requirements for each component of the selected remedy.

A. Surge Ponds

Design, construction, and operation of the ponds will be governed by several sets of requirements. As discussed previously, several location-specific requirements and the requirements governing the interim treatment facility will be ARARs for the surge ponds. In addition, certain requirements from Federal and State waste management regulations are considered ARARs for the surge ponds. These are described below.

The Federal and State solid waste regulations contain requirements applicable to the ponds. The Criteria for Classification of Solid Waste Disposal Facilities and Practies, 40 C.F.R. Part 257, include criteria related to surface water, ground water, air, and safety which are relevant to design, construction, and operation of the ponds. See 40 C.F.R. sections 257.3-3, .3-4, .3-7, and .3-8. These provisions are principally aimed at municipal and industrial solid waste and do not fully address concerns related to mining waste. See 51 Fed. Reg. 24,496, 24,501 (1986). Regulations promulgated pursuant to the State Solid Wastes Disposal Sites and Facilities Act, Colo. Rev. Stat. sections 30-20-101 to -118, provide for more substantial public health and environmental protection. Specifically, sections 2.1, 2.2, 4.1, 4.2, 6.2, 6.3, 6.4, 6.5, 6.6, and 6.7 of 6 Colo. Code Regs. 1007-2 are considered ARARs for the ponds.

Provisions of regulations governing hazardous waste are also ARARs. Under 40 C.F.R. section 261.4(b)(7), solid waste from the extraction, beneficiation, and processing of ores and minerals is not considered a hazardous waste. However, under CERCLA, hazardous waste regulations may be relevant and appropriate under the circumstances of the release. See Memorandum from Henry L. Longest II to Waste Management Division Directors regarding Condsideration of RCRA Requirements in Performing CERCLA Responses at Mining Waste Sites (Aug. 19, 1986).

To ensure that the design, construction, and operation of the ponds are protective of human health and the environment, the following requirements are considered ARARs for the ponds: 40 C.F.R. sections 264.15 (general inspection requirements), 264.16(a) (personnel training), 264.31 (design and operation of facility), 264.32 (required equipment), 264.33 (testing and maintenance of equipment), 264.37 (arrangements with local authorities), and 264.51-.56 (contingency plans). In addition to these general requirements, the requirements for surface impoundments governing design and operation, monitoring and inspection, and emergency repairs and contingency plans are also ARARs. 40 C.F.R. sections 264.221, .226, .227. To the extent that the State has more stringent requirements associated with these regulations, the more stringent State requirements would govern.

B. Tunnel Plugging

EPA and the State identified no ARAR's related to tunnel plugging. To ensure protection of public health and the environment, the plugs must be designed and constructed using best engineering practices. In addition, EPA will look to requirements under the Surface Mining Control and Reclamation Act, 30 U.S.C. sections 1201-1328, for guidance to see that activities associated with tunnel plugging are protective. Specifically, EPA will look to the permanent program performance standards for underground mining activities set forth in 30 C.F.R. Part 817. These regulations are not ARARs, since they apply to coal mining activities. However, they are designed to ensure that underground mining activities are conducted in a manner which preserves and enhances environmental and other values. See 30 C.F.R. section 817.2. The performance standards will be used as appropriate.

C. Water Control Measures

Location, design, and construction of the surface water control measures will be governed by the location-specific requirements discussed above. In addition, as with tunnel plugging, EPA will look to requirements of the Surface Mining Control and Reclamation Act for guidance to see that activities associated with water control measures are protective of public health and the environment. The regulations set forth in 30 C.F.R. Part 817 will be used as guidance for the water control measures.

D. Monitoring

The Colorado Water Well and Pump Installation Contractors Act discussed previously provides minimum standards for the location, construction, modification, and abandonment of wells. The monitoring component of the selected remedy provides for the construction of monitoring wells. Pursuant to section 121(e) of SARA, a permit is not required for the monitoring wells installed onsite. For onsite wells, the substantive requirements of the Water Well and Pump Installation Contractors Regulations, 2 Colo. Code Regs. 402-2 will be met. For offsite wells, both substantive and procedural requirements must be met and permits will be obtained.

In addition, any investigation-derived wastes must be handled, treated, and disposed of in compliance with all applicable requirements.

E. Water Collection System

The Colorado Water Well and Pump Installation Contractors Act, Colo. Rev. Stat. sections 37-91-101 to -112, establishes requirements relating to the installation, modification, and repair of pumping equipment. The mine water collection system will pump water from behind the portal plug. Although a permit is not required for onsite response actions, all substantive requirements must be met. Therefore, the collection system will be designed, installed, and maintained in accordance with the substantive requirements of 2 Colo. Code Regs. 402-2.

F. Interim Treatment Facility

Under the Clean Water Act and the Colorado Water Quality Control Act, a permit must be obtained for the discharge of pollutants from any point source into waters of the United States. Under section 121(e) of SARA, no federal, state, or local permits are required for onsite remedial actions selected and implemented in compliance with section 121. Since the interim treatment facility and the outfall will be located entirely onsite, no permit will be obtained. Nevertheless, in accordance with EPA's "Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements," the treatment facility will comply with the substantive requirements. To the extent that State requirements are more stringent than Federal requirements, the State requirements will govern.

Under the Clean Water Act and the Colorado Water Quality Control Act, water treatment facilities must meet technology-based effluent limitations and standards. Technology-based treatment requirements under section 301(b) of the Clean Water Act, 33 U.S.C. section 1311, represent the minimum level of control that must be achieved. See 40 C.F.R. section 125.3(a). For the interim treatment facility, these requirements are (1) the best practicable control technology currently available ("BPT"), (2) for conventional pollutants, the best conventional pollutant control technology ("BCT"), and (3) for toxic and other nonconventional pollutants, the best available technology economically achievable ("BAT"). See 40 C.F.R. section 125.3(a)(2).

The application of technology-based treatment requirements depends on the type of discharge. EPA has promulgated effluent limitations for particular industrial categories and subcategories. The Ore Mining and Dressing Point Source Category contains provisions applicable to mines that produce copper, lead, zinc, gold, silver, or molybdenum bearing ores, or any combination of these ores from open-pit or underground operations other than placer deposits. 40 C.F.R. section 440.100(a)(1). These provisions establish effluent limitations for application of BPT, BAT, and new source performance standards. 40 C.F.R. sections 440.102(a), 440.103(a), 440.104(a).

These effluent limitations are not legally "applicable" as the CERCLA response action is not a mining activity. However, the effluent limitations were designed to address problems and situations similar to those of the Yak Tunnel operable unit. The pollutants are similar to those that would be encountered in gold, copper, lead, zinc, or silver mines, and the mine water collection and treatment system component of the selected remedy is similar to a typical mine dewatering operation. These requirements are therefore considered an ARAR.

Additional substantive requirements for the National Pollutant Discharge Elimination System program are set forth in 40 CFR Parts 122 to 125. These regulations establish, among other things, a duty to mitigate, requirements for proper operation and maintenance of the treatment system, and provisions governing bypasses and upsets. See 40 CFR section 122.41(d)-(n). Also, to ensure compliance with the discharge limitations, the requirements governing monitoring, recordkeeping, and reporting must be met. See 40 C.F.R. sections 122.21, 122.41, 122.44 and 122.45, 122.48, and 40 CFR Part 136. Also, best management practices programs are to be developed in accordance with 40 C.F.R. section 125.104. In addition, any substantive State requirements more stringent than the Federal requirements would also apply.

During the design phase, the interim treatment facility will be designed to meet the substantive federal requirements of the Clean Water Act and regulations and any more stringent State requirements.

G. Disposal of Sludge and Excavated Soils

During the course of construction and operation of the selected remedy, waste materials requiring storage or diposal will be produced. The interim treatment facility will produce sludges requiring storage or disposal. Also, during construction of the ponds and the surface water diversions, there may be excavations which produce wastes requiring disposal.

As described in the ROD, EPA anticipates that sludge generated by the interim treatment facility can be stored in the surge ponds until a final remedy is developed. For interim storage, the ARAR's are the same as those discussed above with respect to the ponds. If sludge generation exceeds the pond storage capacity, two additional options are available. The ARAR's for these options are described below.

1. Processing in an Existing Mill or Consolidation in an Active Tailings Pond

The ARARs are all Federal and State public health and environmental requirements applicable to the milling operation or tailings pond. In addition, SARA establishes special requirements associated with transfer of hazardous substances or pollutants or contaminants to an offsite facility. Under section 121(d)(3) of SARA, the sludge can be transferred only to offsite facilities in compliance with all applicable Federal and State requirements. To ensure protection of public health and the environment, EPA must determine that the facility is in compliance with Federal and State requirements before sludge is taken either to an offsite or onsite mill or tailings pond.

2. Interim Storage and Disposal

In addition to the location-specific requirements discussed above, provisions of both Federal and State waste management requirements would be ARARs for interim storage or disposal of sludge. The Federal Criteria for Classification of Solid Waste Disposal Facilities and Practices, 40 C.F.R. Part 257, establishes minimum criteria for surface water, ground water, air, and safety. 40 C.F.R. sections 257.3-3, .3-4, .3-7, .3-8. Sections 2.1, 2.2, 4.1, and 4.2 of the State Solid Wastes Disposal Sites and Facilities Regulations establish further requirements for waste disposal. 6 Colo. Code Regs. 1007-2. Any sludge disposal facility will be designed in accordance with both Federal solid waste requirements and more stringent State requirements.

Although the sludge would be exempt from regulation as a hazardous waste under 40 C.F.R. section 261.4(b)(2), some provisions governing hazardous waste storage and disposal are relevant and appropriate. The following provisions are ARARs for management of the treatment facility sludge: 40 C.F.R. section 264.13(a)(1)-(2) (general waste analysis), 264.14 (security), 264.15 (general inspection requirements), and 264.31 (design and operation of facility). In addition, certain provisions governing landfills would also be ARARs: 40 C.F.R. section 264.301 (design and operating requirements), 264.303(a)

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(monitoring and inspection), and 264.309 (surveying and recordkeeping).

There are also two options for disposal of excavated soils. These can be consolidated with an existing waste pile for remediation in a subsequent operable unit, provided that the soils are stabilized to prevent migration of hazardous substances, pollutants, or contaminants. Specifically, it will be necessary to controll run-on, run-off, and fugitive dust. Therefore, 40 C.F.R. sections 264.251(c), (d), and (f) have been identified as ARAR's for disposal of excavated soil in waste piles. Any potential ground water impacts will be addressed in a subsequent operable unit. Excavated soils may also be managed in the same manner as in the treatment facility sludge.

H. Operations and Maintenance

ARARs for operations and maintenance are discussed in the context of the ARARs for specific components of the remedy.

I. Worker Health and Safety

The Occupational Safety and Health Act, 29 U.S.C. sections 651 to 678, and the Federal Mine Safety and Health Act, 30 U.S.C. sections 801-962, establish requirements to protect worker health and safety. Under 40 C.F.R. section 300.38, applicable health and safety requirements apply to all response activities under the National Contingency Plan. These requirements will apply to all components of the selected remedy.

Appendix D
STATEMENT OF FINDINGS CONCERNING FLOODPLAINS AND WETLANDS

Appendix D
STATEMENT OF FINDINGS CONCERNING FLOODPLAINS AND WETLANDS

INTRODUCTION

EPA has determined that the selected remedy will be located in or affect a floodplain or wetlands. Therefore, EPA prepared this Statement of Findings in accordance with Executive Order 11988 entitled "Floodplain Management" (May 24, 1977), Executive Order 11990 entitled "Protection of Wetlands" (May 24, 1977), 40 CFR section 6.302 and Appendix A, and EPA's "Policy on Floodplains and Wetland Assessments for CERCLA Actions" (August 6, 1985).

During the Phase I RI, EPA identified both a floodplain and wetlands along California Gulch (Figure 2-6, EPA, 1987a). EPA established an approximate boundary for the 100-year floodplain using data from a Corps of Engineers study (Corps of Engineers, 1983). The flood hazard boundary determination was made using "Approximate Study Criteria" as applied by the Federal Emergency Management Agency. No Flood Insurance Rate Maps or Flood Hazard Boundary Maps are known to exist for the site. Potential wetland areas near Stringtown, 2 to 2 1/2 miles below the Yak Tunnel portal, were identified from aerial photographs. The existence of wetlands along California Gulch was confirmed by a field inspection.

WHY THE PROPOSED ACTION MUST BE LOCATED IN OR AFFECT THE FLOODPLAIN OR WETLANDS

Several components of the selected remedy must be located in or will affect the floodplain. Some of the water control measures, including grouting, shaft sealing, and measures to prevent surface water infiltration, will be located in the floodplain. Because certain mine shafts, recharge areas, and areas of potential seepage are already located in the floodplain, it is necessary to construct water control measures in the floodplain for effective control of infiltration and seepage. The same is true for surge ponds. For the ponds to intercept and collect surge flows effectively, the ponds must be constructed near the tunnel portal. This area may lie totally within the 100-year floodplain.

No components of the selected remedy will be located in wetlands. However, the selected remedy may affect the wetlands along lower California Gulch. Currently, Yak Tunnel discharge is a primary source of continuous flow for California Gulch. Tunnel plugging will substantially reduce the contribution of the tunnel to surface water flow in California Gulch and will probably reduce flow to the wetland areas. The precise impacts cannot be determined until the remedy is implemented.

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SIGNIFICANT FACTS CONSIDERED IN MAKING THE DECISION TO LOCATE IN OR AFFECT THE FLOODPLAIN OR WETLANDS INCLUDING ALTERNATIVE SITES AND ACTIONS

EPA based it decision on the following considerations.

1. Ground water modeling indicates that the portal plug may cause ground water to seep to the land surface. Reducing infiltration to mine workings behind the portal plug will reduce water levels and will thereby decrease the potential for uncontrolled seepage of contaminated water. If seepage cannot be controlled, it will be necessary to operate the pumping and treatment system. Reducing infiltration will reduce the quantity of water requiring treatment and the amount of sludge generated. Some of the shafts, drill holes, caved-in mine workings, and other recharge areas are in the floodplain. No alternative sites or locations could effectively reduce infiltration from these recharge areas.

2. Surges are instantaneous, uncontrolled releases of large volumes of water, sludge, and sediments. It will be necesssary to construct ponds near the tunnel portal to use gravity drainage to intercept surge flows. The portal may lie within the 100-year floodplain. The area near the portal is a narrow valley, which limits the sites available for pond construction. Because of the geographical restrictions and the size of the ponds, it will be necessary to locate them within the 100-year floodplain. It is infeasible to pipe or pump surge flows to another location as the peak flows during surges are unpredictable and sludges could clog the pipes.

3. EPA evaluated alternative remedies and determined that the selected remedy will best address the Yak Tunnel discharge and offers the greatest long-term environmental protection, despite the potential effect on wetlands in California Gulch.

WHETHER THE PROPOSED ACTION CONFORMS TO APPLICABLE STATE OR LOCAL FLOODPLAIN PROTECTION STANDARDS

Discussions with State and Lake County officials indicate that no flood hazard boundaries exist and no State or local floodplain protection standards have been established for the portion of the site where the response actions will occur.

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STEPS TAKEN TO DESIGN OR MODIFY THE PROPOSED ACTION TO MINIMIZE POTENTIAL HARM TO OR WITHIN THE FLOODPLAIN OR WETLANDS

To protect the surge ponds, a flood control channel will be designed and constructed to convey flood flows of up to the 100-year flood from upper California Gulch around this facility. This feature will protect the treatment facility from flood damage up to the 100-year flood and will thus minimize the potential release of contaminants from the treatment plant to lower California Gulch and the Arkansas River. Further, the ponds will be designed to prevent washout by floods up to the 100-year event by including a minimum of 3 feet of freeboard on the dikes above the 100-year flood level.

Water flow to the wetlands near Stringtown will be reduced because of the tunnel plugging. However, at the same time, the remedy may improve water quality in California Gulch and could thus have beneficial impacts on wetlands. EPA will determine measures to mitigate impacts on wetlands during the design phase, and, if necessary, during remedy implementation.

HOW THE PROPOSED ACTION AFFECTS THE NATURAL OR BENEFICIAL VALUES OF THE FLOODPLAIN OR WETLANDS

Floodplains provide beneficial values by allowing natural storage of floodwater, thus protecting downstream natural and manmade features from flood-related damage. Construction of the surge ponds in the 100-year floodplain will cause a limited backwater effect upstream and a limited zone of influence downstream as higher velocity flows from the restricted channel in the vicinity of the treatment plant reach the natural California Gulch channel capacities. The exact limits of these effects and influences have not been calculated. However, they are expected to be minimal due to the relatively small size of the facilities compared to the storage capacity of the floodplain. These localized effects should not adversely affect the beneficial value of the floodplain for protecting developed property or human safety, health, and welfare.

Wetlands provide biological, environmental, and aesthetic values. Widespread surface distrubance from mining activities has diminished the natural and beneficial values of the wetlands along California Gulch. Even so, reduced flow in California Gulch may further diminish these values. However, reducing the metals loads in California Gulch will result in an overall enhancement of environmental quality.

REFERENCE

U.S. Army Corps of Engineers, Omaha District. California Gulch Tailings Dams, October 7, 1983. Prepared for the EPA--Phase I Inspection Reports. October 1983.

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I. OVERVIEW

EPA presented its Proposed Remedial Action Plan (Proposed Plan) for the Yak Tunnel Operable Unit for public comment and review on August 18, 1987. In its proposed plan, EPA's preferred remedial action alternative was to collect and treat the discharge from the Yak Tunnel. EPA also retained the option to include a partial plugging component.

During the public comment period and public meeting, the need to address Yak Tunnel contamination was not questioned, but EPA's proposed alternative received extensive comment. Some members of the public supported a remedy that could provide some local employment and keep the tunnel open for future mineral resource development. A majority criticized the proposed remedy because of concerns associated with permanent rehabilitation of the Yak Tunnel and because the remedy would include a perpetual treatment operation rather than a permanent solution to the acid drainage problem. The costs of operating the treatment facility into perpetuity, and to what extent the residents may have to eventually bear those costs, concerned many of the local residents.

During the public meeting, ASARCO Incorporated presented an alternate remedy for consideration. This remedy involved installation of four plugs in the Yak Tunnel plus an in situ treatment system for the water stored in the mine workings behind the portal plug. This treatment system would involve pumping ground water to the surface, mixing it with lime, and reinjecting it back into the mine workings.

Based on comments and information received during the public comment period, EPA re-evaluated and modified its preferred remedial action alternative. The selected remedy includes the installation of three plugs within the Yak Tunnel and construction of surge ponds to collect any material dislodged during entry into or construction in the tunnel. The selected remedy also includes water control measures to minimize the infiltration of surface water into the mine workings and tunnel. In addition, the remedy incorporates measures to control the potential seepage of contaminated ground water rising behind the portal plug to the land surface. Highly fractured rock in the vicinity of the tunnel portal will be grouted and, if necessary, the water level behind the portal plug will be controlled so that seepage does not occur. This will be achieved by pumping water from behind the portal plug until a lower water level is achieved. Water extracted from behind the plug will be treated with lime to remove metals and released to the ponds constructed for surge control during plug installation. The remedy also includes monitoring, operations and maintenance, and contingency plans.

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The selected remedy addresses many of the concerns raised during the public comment period. Tunnel plugging and water control measures will minimize the amount of water requiring treatment and, hence, offer a more permanent solution. Temporary tunnel rehabilitation will be undertaken only to the extent necessary for installation of the plugs. Thus, concerns about worker safety and the costs of tunnel rehabilitation and maintenance have been addressed. EPA did not select ASARCO's proposal for in situ treatment because of uncertainty about its effectiveness. However, if further study of this proposal demonstrates its effectiveness, in situ treatment may be considered.

The following sections of this Responsiveness Summary describe the background on community involvement in remedy selection, public comments and corresponding EPA responses, differences between the proposed plan and the selected remedy, and remaining concerns.

II. BACKGROUND ON COMMUNITY INVOLVEMENT

EPA began Superfund activities at the site in 1982 and has since maintained frequent contact with members of the community. Local officials and a number of community groups have been involved, including the Lake County Board of County Commissioners, the City of Leadville, the Lake County Environmental Task Force, the Lake County branch of the Soil Conservation Service, and the Leadville-Lake County Mined Land Reclamation Group.

Community interest and concern about the California Gulch site is high. There has been much community involvement in site activities, particularly over the past 2 years. During the Superfund process to date, EPA has released a Phase I Remedial Investigation (RI) and a Yak Tunnel Feasibility Study (FS).

For the Yak Tunnel FS, EPA held a 90-day public comment period to allow the public to review and comment on the FS and the proposed remedial action. This recent activity, along with previous interviews and discussions with community members, has highlighted the following major concerns.

1. Many members of the community are [illegible] with the actions of the Federal and State agencies in the area. Specifically, they are concerned with the cost of the investigations, that the State and Federal governments have unnecessarily duplicated efforts, and that the process as it relates to Superfund is confusing.

   EPA Response. EPA is the lead agency for Superfund activities at the California Gulch site. EPA and the State have clarified their roles and responsibilities at the site. EPA is continuing to inform the public about the Superfund process.

2. Many community members are concerned about the Superfund cost recovery provisions. Residents are concerned about the potential economic impact of cost recovery on individuals within Leadville, on the mining companies, and ultimately on employment in the community.

   EPA Response. The cost recovery provisions are set forth by statute. EPA will help the community to understand these provisions. In accordance with the law, EPA will select cost-effective remedies.

3. Members of the Lake County Environmental Task Force and local officials would like to have more direct involvement and input into the technical aspects of the RI/FS process.

EPA Response. In response to community concern, EPA is planning opportunities for substantial public involvement in studies for subsequent operable units.

4. Stringtown residents have voiced concern about the contamination on their properties. They feel that EPA is focusing on other aspects of the site and not their neighborhood.

   EPA Response. Subsequent operable units will address environmental and public health issues in Stringtown.

5. Local residents are concerned about possible adverse effects of contaminated surface water on the use of the Arkansas River as a fishery and for irrigation.

   EPA Response. The selected remedy for the Yak Tunnel addresses a major source of contaminants to the Arkansas River. EPA plans to implement further actions at the site to reduce the impact of contaminants on the Arkansas River.

6. Some community members are concerned with the negative image associated with the site and its potential effect on tourism. Community members would like to emphasize the positive aspects of mining and avoid negative connotations, particularly inaccurate perceptions of health problems associated with mining wastes.

   EPA Response. EPA appreciates and recognizes that the mining legacy of Leadville is a valuable resource. In the long-term, cleanup of the California Gulch site will protect public health, welfare, and the environment.

III. SUMMARY OF PUBLIC COMMENTS AND AGENCY RESPONSES

The public comment period was held from July 7 to October 5, 1987, and included a public meeting in Leadville on September 1, 1987. Comments received during the comment period on the FS and Proposed Plan are summarized below. The comments are categorized by topic and an index is provided at the end of this section so that commenters can locate where their specific comments are addressed. The topics are: operable unit approach, remedial alternative preferences, other potential technologies, public health and environmental assessment, applicable or relevant and appropriate requirements (ARARs), costs, technical issues in the FS and Proposed Plan, public participation process, and other comments.

OPERABLE UNIT APPROACH

ASARCO Incorporated (ASARCO), Hecla Mining Company (Hecla), Leadville Corporation, and Resurrection Mining Company and Newmont Mining Corporation (Resurrection) disagreed with EPA's operable unit approach for the Yak Tunnel. Specific comments are described below.

1. Resurrection stated that EPA incorrectly defined the operable unit because, while the Yak Tunnel discharge is a discrete component of the site, the Yak Tunnel itself and the influence of the tunnel on surface water and ground water regimes throughout the site are not "discrete."

   EPA Response. EPA agrees that "the influence and relationship of the Yak Tunnel on the overall site is not discrete and measurable;" i.e., the harm from the Yak Tunnel is indivisible. However, under the National Contingency Plan (NCP), an operable unit is defined as "a discrete part of the entire response action that decreases a release, threat of release, or pathway of exposure" (40 CFR Section 300.6). Thus, an operable unit is a discrete part of the response action, not a discrete part of the contamination problem.

2. ASARCO commented that EPA failed to define the operable unit specifically, which would assist ASARCO in evaluating the appropriateness of the operable unit.

   EPA Response. EPA relied on the NCP definition of "operable unit," which encompasses response actions that decrease a release, threat of release, or pathway of exposure. In the Phase I RI Report and the FS, EPA defined and characterized the release and threatened release of hazardous substances, pollutants, and contaminants from the Yak Tunnel portal into California Gulch surface waters. In the FS, EPA identified and evaluated specific response actions that would decrease this release and threat of release. EPA believes that further definition of the operable unit is unnecessary to the evaluation of the operable unit approach or selection of remedy.

3. ASARCO, Leadville Corporation, and Resurrection questioned whether the operable unit remedy would be cost-effective. It was suggested that premature selection of remedy for the Yak Tunnel operable unit could unnecessarily complicate or prove counterproductive to the overall site remedy. These commenters also stressed the importance of an integrated approach to the entire site and the inefficiencies and inconsistencies that could be associated with an operable unit approach. ASARCO noted specifically that cleanup standards, goals, approaches, methodologies, and technologies for the Yak Tunnel operable unit may be inconsistent with the remediation ultimately required for the rest of the site. Each of these commenters suggested that integration with the full-site remedy would help ensure that the operable unit response actions were cost-effective.

   EPA Response. Under Section 300.68(c)(3) of the NCP, an operable unit may be implemented before selection of an appropriate final remedial action, provided that the operable unit measures are cost-effective and consistent with a permanent remedy. EPA recognizes the need for an integrated approach to site remediation. In response to public comment, EPA has modified the remedy described in its Proposed Plan to promote integration with response actions for other portions of the site. The tunnel plugs and water control measures are part of the permanent remedy for the site. An interim treatment facility was selected so that a comprehensive approach to water treatment at the site may be implemented in a subsequent operable unit. Given these modifications, EPA believes that the operable unit will be well integrated with the full-site remediation.

4. Hecla suggested integration of remedial action through synchronization and coordination of operable units, particularly noting the need for a carefully planned and executed sequence of remedial actions, with construction and transportation schedules, and logistical plans so that any particular remedial action does not negatively affect an already completed remedial action. Hecla also offered specific suggestions on how treatment plant location and sludge will be temporarily stored in the surge ponds.

EPA Response. EPA agrees with this comment and will endeavor to achieve such integration and coordination with subsequent operable units. The selected remedy addresses concerns about inconsistencies arising from treatment plant location, and sludge will be temporarily stored in the surge ponds. Permanent sludge disposal options will be addressed in a subsequent operable unit.

5. ASARCO and Hecla stated that the NCP requires that remedial actions for an operable unit be consistent with the final remedy for the entire site. ASARCO further argued that EPA's alternatives evaluation for the Yak Tunnel was premature, temporary, and perhaps incompatible with final remedial measures for the whole site. This commenter also noted that EPA could predict the consistency of an operable unit remedy only if EPA already decided internally what the site-wide remedy will be. Resurrection asserted that, without knowing the permanent remedy, it is impossible to select an operable unit remedy that is consistent with a permanent remedy.

   EPA Response. EPA disagrees with ASARCO's and Hecla's interpretation of the NCP requirement. The language of the NCP requires that the operable unit response actions be "consistent with a permanent remedy." See 40 CFR Section 300.68(c)(3). The NCP does not require, as these commenters assert, that the operable unit be consistent with the final remedy for the entire site. EPA has not yet selected a remedy for the entire California Gulch site, nor is it required to do so by the NCP before selecting a remedy for this operable unit. EPA has selected operable unit response actions that are "consistent with a permanent remedy." By this, EPA means both that the response actions are intended to be a part of a full-site remedy and that they do not foreclose or limit implementation of other operable units in the future.

6. ASARCO, Hecla, Leadville Corporation, and Resurrection suggested that the selection of remedy for the Yak Tunnel is premature. They commented that no remedy can appropriately be selected for the Yak Tunnel operable unit until EPA has completed the full-site remedial investigation and selected remedies for the entire site, including all other sources of contamination.

   EPA Response. EPA believes that an operable unit approach for the Yak Tunnel is appropriate at this time. The purpose of an operable unit is to allow EPA to take steps to alleviate threats to public health or welfare or the environment prior to development or implementation of a complete remedial action. The Yak Tunnel releases an estimated 210 tons of metals per year into California Gulch surface water and is a major source of metals contamination at the site. The selected remedy will substantially decrease the release and threat of release of hazardous substances, pollutants, and contaminants from the Yak Tunnel portal and will have a beneficial effect on surface waters. EPA sees no benefit to delaying implementation of the selected remedy. Substantial harm will continue if the tunnel releases are unabated.

7. In a related comment, Hecla suggested that selecting a treatment remedy for the Yak Tunnel prior to remedy selection for the remainder of the site could foreclose opportunities to integrate treatment plant design and location and sludge disposal options.

   EPA Response. This comment has been addressed through refinement of the selected remedy. Construction of an interim treatment facility will permit the design and siting of a comprehensive treatment system in conjunction with a subsequent operable unit. As discussed above, sludge will be temporarily stored in the surge ponds so that a permanent disposal option can be implemented in conjunction with a future operable unit.

8. ASARCO stated that any rational operable unit for the Yak Tunnel must include upper California Gulch and stabilization of tailings ponds in lower California Gulch.

   EPA Response. In EPA's remedy, a portion of the remedy will involve response actions in upper California Gulch to seal surface openings for ground water infiltration into the Yak Tunnel. In addition, response actions related to the tailings ponds may be necessary for construction of surge ponds and treatment facilities and will be determined during the design phase. The remainder of upper California Gulch, which includes widespread surface disturbance and waste piles, and additional work on tailings ponds will be addressed in a subsequent operable unit.

9. ASARCO and Resurrection commented that the operable unit and the California Gulch site as a whole should be expanded to include additional source areas throughout the upper Arkansas River, particularly other nearby mining areas and the Leadville Drainage Tunnel.

EPA Response. EPA is not persuaded that the scope of the operable unit should be expanded. It is recognized that there are numerous other sources of contamination at the site. However, it is not necessary to address all sources simultaneously. Many of these sources and areas are geographically distant from the Yak Tunnel, have different waste characteristics (e.g., waste piles), and potentially involve distinctly different remediation technologies. The size and scope of the site will be determined in subsequent operable units. The Yak Tunnel operable unit was designed flexibly to permit integration with future operable units. The Leadville Drainage Tunnel discharge is being addressed by the Bureau of Reclamation under the Clean Water Act.

10. Hecla asserted that preparation of separate RI/FSs for different parts of the site would be duplicative, repetitive, needlessly costly, and a waste and misuse of valuable technical talent.

    EPA Response. EPA does not believe that preparation of separate RI/FSs for various operable units need necessarily be duplicative or repetitive. Subsequent operable units will gather environmental data not previously studied. EPA further believes that conducting the response action in operable units is necessary to address this large and complex site appropriately.

REMEDIAL ALTERNATIVE PREFERENCES

Numerous parties made comments expressing preferences about the remedial alternatives developed by EPA and the alternative identified in the Proposed Plan (Alternative 5). These are summarized below.

1. Leadville Corporation supported Alternative 7 as "viable and workable" and the "most viable approach," and also noted that Alternative 2 may have merit. Leadville Corporation also found merit with the employment opportunities proposed by Alternative 4, but agrees with EPA that this alternative is unreliable, likely to create substantial adverse environmental impacts, and extremely difficult and expensive to undertake.

   EPA Response. EPA acknowledges and appreciates the comment. EPA has incorporated the tunnel plugging aspects of Alternative 7 into the selected remedy. Alternative 2 is discussed below.

2. Hecla commented that Alternatives 5 and 7 were incorrectly selected as suitable actions because: (1) the consequences of neither are identified nor addressed, (2) the alternatives they were compared

against were not properly evaluated, and (3) they do not fulfill the intent of the operable unit approach.

EPA Response. EPA disagrees with these contentions. Alternatives 5 and 7 were developed through a technology screening, alternative identification, and initial alternative screening process that meets the requirements of Section 121 of SARA, the NCP, and OSWER Directive 9355.0-19. These two alternatives were selected for detailed analysis because they best meet the implementability and effectiveness criteria presented in Section 7 of the FS. Both alternatives have the greatest potential to attain the ARARs established for this operable unit.

3. ASARCO provided discussion and comments for each of the 11 alternatives developed and evaluated by EPA for the Yak Tunnel FS. ASARCO also presented two additional alternatives.

   EPA Response. EPA appreciates ASARCO's comments in response to remedial alternatives developed in the FS. Careful consideration was given to these comments during selection of the Yak Tunnel remedy.

4. ASARCO stated that neither Alternative 5 nor Alternative 7 should have passed the screening process because (1) it is not feasible to rehabilitate and maintain the tunnel, (2) the proposed treatment plant is flawed, and (3) the perpetual sludge disposal problem of such treatment was not addressed.

   EPA Response. For reasons discussed in the previous response, EPA disagrees with these contentions. Both Alternative 5 and 7 are technically feasible; tunnel rehabilitation can be accomplished using specialty contractors and standard mining technologies. The lime High Density Sludge treatment process is a proven process and perpetual disposal of sludge was acknowledged and addressed in Sections 5, 7, and 8 of the FS.

5. Both ASARCO and Hecla commented that EPA's Alternative 2 should have passed the screening process and been carried through detailed analysis.

   EPA Response. EPA conducted the initial screening of alternatives in compliance with Section 121 of SARA, the NCP, and OSWER Directive 9355.0-19. Alternative 2, as defined in the FS, does not meet the criteria for implementability (questionable reliability in halting the discharge of acidic water to California Gulch) and effectiveness (inability to meet cleanup criteria for the Yak Tunnel effluent) and was, therefore, dropped from further consideration in detailed analysis of alternatives. Nevertheless, EPA recognizes that Alternative 2, with modifications to control seepage of contaminated water, may be an effective remedy. The selected remedy incorporates elements of Alternative 2.

6. Leadville Corporation suggested that if EPA decides to build the chemical wastewater treatment plant, wetlands treatment should also be considered as a tertiary treatment system and an emergency back-up should the chemical treatment plant fail for some reason. Leadville Corporation also discussed the possibility of rehabilitating tailings ponds into wetlands.

   EPA Response. EPA has selected an interim lime treatment facility for this operable unit. Wetlands treatment, which presents potential benefits, will be evaluated further as part of a comprehensive treatment alternative during a subsequent operable unit.

7. Resurrection stated that partial plugging of the Yak Tunnel to isolate the Ibex-Irene Group and Resurrection-Diamond Group of mines should be one of the initial remedial activities under any scenario. According to Resurrection, partial plugging of the mine workings, combined with a surface water infiltration reduction program, is a logical and reasonable first step in the remediation process.

   EPA Response. EPA agrees with this comment. The selected remedy includes plugging of the Ibex-Irene and Resurrection Group of workings and a surface water infiltration reduction program.

8. Resurrection stated that Alternative 5 is not a reasonable component of overall site remediation and is not technically effective or cost-effective.

   EPA Response. As discussed in the FS and Proposed Plan, EPA believes that Alternative 5 would be effective, implementable, and cost-effective. However, EPA also believes that the selected remedy offers greater potential for long-term reduction in mobility and toxicity of metals. The selected remedy also offers a flexible approach for integration with the full-site remedy.

9. Hecla stated that Alternative 5 has major disadvantages in that it is not a permanent remedy as it would require perpetual treatment and it would incorporate offsite disposal. Hecla further asserted that EPA disregarded alternatives, such as plugging, which

potentially represent a permanent solution and do not require offsite disposal. Hecla also noted that treatment was not a permanent remedy in that the hazardous substances are not destroyed or neutralized.

EPA Response. EPA evaluated a range of plugging alternatives in the FS and retained a plugging option in the Proposed Plan. The selected remedy includes a plugging component, because plugging offers a greater potential for a permanent remedy. EPA disagrees with Hecla's comments concerning offsite disposal; sludge disposal could occur onsite. Also, it should be noted that there is no treatment process to destroy metals permanently, so the range of permanent treatment options is relatively limited. Nevertheless, treatment can reduce the toxicity of metals permanently by limiting their bioavailability. The interim treatment facility will serve this function.

10. Hecla stated that the preferred alternative has significant adverse effects and very limited environmental benefits and that other alternatives, including plugging and a unified approach to the site, may have fewer environmental impacts and greater environmental benefits.

EPA Response. As discussed above, the selected remedy incorporates a plugging component and offers a flexible and unified approach to remediation of the site.

11. Hecla stated that EPA has failed to establish that the preferred alternative will be effective in attaining cleanup goals and standards in perpetuity. Hecla further stated that the total plugging alternative would satisfy all ARARs.

EPA Response. As documented in the FS, EPA determined that Alternatives 5 and 7 offered the best approach to attainment of cleanup goals for the site. Since the Yak Tunnel is only one of many sources of metals contamination at the site, a remedy for the Yak Tunnel alone is unlikely to result in attainment of chemical-specific ARARs (see Appendix C of the Record of Decision). Nevertheless, a significant reduction in metals loadings can be achieved. EPA disagrees that total plugging as described in Alternative 2 would attain ARARs because of the potential for uncontrolled surface seepage of contaminated water.

12. Hecla suggested that Alternative 2 could be improved through postplugging monitoring programs, coupled with extraction systems, to contain any contaminated seepage.

EPA Response. The selected remedy includes several components to address the potential for contaminated seepage. Grouting will be used to minimize and control seepage. If necessary, water behind the portal plug will be collected and treated. A monitoring program will be implemented.

13. The Department of the Interior commented that if the tunnel is plugged or partially plugged, a series of wells to monitor quantity and quality of adjacent ground water is essential. The Department of Interior further stated that the selected remedy must require corrective action by the entity responsible for plugging, should monitoring indicate potential problems relating to the Leadville Drainage Tunnel.

    EPA Response. The selected remedy includes a monitoring component to provide for evaluation of localized and regional ground water and surface water impacts. Appendix A of the Record of Decision contains the results of conceptual hydrogeologic modeling to predict ground water impacts under various scenarios. This conceptual model indicates that any increase in flow toward the area drained by Leadville Drainage Tunnel should be minimal. The modeling will be supplemented by field measurements, both before and after plugging, using the monitoring program described in the Record of Decision. The selected remedy includes implementation of contingency measures, if necessary.

14. Hecla commented that the preferred alternative described in the Proposed Plan does not represent "a cost-effective alternative that effectively mitigates and minimizes threats to and provides adequate protection of public health and welfare and the environment" as required by 40 CFR Section 300.68(i).

    EPA Response. EPA disagrees with this comment, but has modified the chosen alternative. The protectiveness and cost-effectiveness of the selected remedy are described in Section VI of the Record of Decision.

15. Hecla commented that EPA failed to establish that the preferred alternative would be effective in attaining cleanup goals and standards in perpetuity.

    EPA Response. The degree to which the preferred alternative would attain ARARs is discussed in the detailed analysis section of the FS. ARARs attainment with respect to the selected remedy is discussed in Appendix C of the Record of Decision.

16. Leadville Mining and Milling Corporation opposes plugging the Yak Tunnel for the following reasons:

plug seals may not be effective and it may not be possible to remedy this by grouting; plugging would hinder its planned mining operations because plugging would deny them easy drainage of water and ventilation; and plugging would impede future mining activity in the Yak Tunnel area because most of the workings would be flooded and the tunnel would no longer be available for access. The company asserts that, consequently, the nation would be deprived of a strategic metal resource and the future economic development of Leadville would be limited.

EPA Response. EPA believes that, with the exception of the portal plug, locations for tunnel plugs can be found that will provide effective seals. Problems are anticipated at the portal plug and these will be dealt with by grouting and/or pumping and treatment in the interim treatment plant.

Tunnel plugging will not impede mining activity. Future drainage and ventilation for mining operations can be provided by other standard means such as pumps, compressors, and shafts. Provision of ventilation, access, and drainage of mine workings are costs of doing business for underground mining. Because of the poor condition of the tunnel, additional investments would be necessary to rely on the tunnel for ventilation and drainage. In addition, point source discharges of water must conform to all applicable environmental laws and regulations.

17. Collegiate Peaks Anglers supports the action that will result in the least polluted discharge into the Arkansas River from California Gulch and the area it drains. In comparing Alternative 5 with the ASARCO Plugging and In Situ Treatment Proposal described below, the group was concerned with aspects of both. However, the members favor Alternative 5 because it would provide treatment that can be visibly monitored. This is preferable, according to the anglers, to a treatment that seems to have many hidden unknowns.

EPA Response. EPA acknowledges the comment and agrees that the selected remedy should result in protection of the Arkansas River. EPA's revised remedy will provide protection of the Arkansas River by reducing the discharge of metals from the Yak Tunnel. ASARCO's proposal is discussed below.

18. Alpenglow Excursions supports total plugging because that alternative keeps the contaminants in the tunnel and eliminates the need for sludge disposal.

EPA Response. EPA acknowledges the comment and has revised its remedy to incorporate tunnel plugging.

19. The Lake County Environmental Task Force expressed opposition to plugging the tunnel. The Task Force commented that the Yak Tunnel system is not a closed one, and that contaminated water would seep through the cracks, faults, and karst caves in the Leadville dolomite and into Evans Gulch, the source of Leadville's drinking water. The Task Force also asked how the changes in site hydrology would be monitored.

    EPA Response. Geohydrologic model studies conducted by EPA indicate that movement of contaminated water to the Evans Gulch area will be minimal. To provide further safeguards, a ground and surface water monitoring program has been made an integral part of the selected remedy. Contingency pump-and-treat measures are also incorporated to deal with problems that may occur.

OTHER POTENTIAL TECHNOLOGIES

In addition to making comments on EPA's proposed alternatives, many reviewers proposed innovative or alternative means of taking remedial action at the Yak Tunnel. These proposals are discussed below.

1. PLUGGING AND IN SITU TREATMENT

Proposal. ASARCO presented its proposal to EPA in August, at the public meeting on September 1, 1987, and in its written comments on the FS and Proposed Plan. ASARCO proposed a remedial action in which four plugs would be set in the Yak Tunnel to stop the discharge of acidic mine drainage to California Gulch. ASARCO's plan also calls for installation of a well and pump station in California Gulch. A conventional deep well would be sunk into the old workings to a level below the Yak Tunnel. Water from the well would be drawn to the surface, mixed with lime, and reinjected into the old workings and plugged tunnel. As the lime and water mixture settle back through the workings, it would react with the dissolved metals, and the metal hydroxides would settle out in the bottom of the workings. The in situ treatment system would be operated until samples taken from the monitoring and pumping wells show that the entire stored water volume had been adequately treated.

If the ground water level reaches a point where water was seeping to the surface or other detrimental effects were noted, the problem would be controlled by pumping water out of the mine. This water would be treated and discharged. The remedy also included surge ponds and surface water diversions.

Several commenters including Collegiate Peaks Anglers, Hecla, and Leadville Corporation supported further investigation into ASARCO's proposal. Leadville Mining and Milling Corporation expressed concern about the proposal.

EPA Response. EPA has taken several elements of ASARCO's proposed remedy into account in developing the selected remedy. The selected remedy includes: (1) surge ponds, (2) plugging the Yak Tunnel in several locations, (3) water control measures, (4) monitoring, (5) installation of a pump and treat system, and (6) contingency plans. EPA did not select the exact specifications of remedial components described in ASARCO's proposal. The design, locations, and specifications of response actions will be determined in the design phase.

EPA did not adopt ASARCO's in situ lime treatment system because of concern about the implementability and effectiveness of this proposal. Due to the complexity of the mine workings, there is a significant possibility that in situ treatment, as proposed, would not achieve sufficient mixing and would thus ineffectively treat water in all areas of the tunnel and related mine workings. In addition, sludge generated by the treatment system may seal off flow paths, causing shortcircuiting of the system and rendering the treatment ineffective. Consequently, as water levels rise behind the portal plug, there could be seepage of contaminated water to the ground surface. EPA disagrees with ASARCO's comment that the proposal would attain ARARs, both because of the potential for contaminated seepage and because of the contribution of other sources to contamination of surface water in California Gulch and the Arkansas River.

Nevertheless, EPA is willing to explore the in situ treatment concept further as it may offer potential for long-term effectiveness. Proceeding with the selected remedy does not preclude further exploration of this concept. In fact, it may provide a means of allowing the in situ treatment system to be tested in the field. The pump and treatment component could be used to control seeps while the monitoring program would allow evaluation of the effectiveness of the in situ treatment.

2. IN SITU TREATMENT

Proposal. The Lake County Environmental Task Force presented a proposal for in situ treatment at the public meeting and in written comments to the EPA. The proposed alternative includes an alkaline injection system in which sodium carbonate would be injected into major recharge zones upgradient of areas of acid formation. By mixing alkaline water with acidic water, heavy metals would precipitate in the form of carbonates and seal the exposed pyritic surfaces. Monitoring would be required to determine the frequency, size, and effectiveness of injections. The proposed plan does not include plugging the tunnel, which the Task Force believes should be kept open and maintained for future mining activities. The Task Force proposed construction of surge protection and short-term treatment ponds to handle discharge from the tunnel. Sludge would be pumped back into the tunnel, and clean water from Leadville Corporation could be added to treated water to further dilute any metals remaining after the process. The Task Force also proposed construction of a pipeline to convey clean water to the lower reaches of California Gulch or the Arkansas River.

EPA Response. Maintaining the tunnel and conducting in situ treatment are not compatible options; some form of contaminated discharge would perpetually leave the tunnel and placing sludge back into an open tunnel increases the potential for environmental damage in the event of a surge. Although the Agency appreciates these suggestions, EPA believes the proposal does not meet the criteria for implementability and effectiveness stated in Section 7 of the FS.

3. CARBON-DIOXIDE TREATMENT

Proposal. TUSCO Incorporated proposed a plan for stopping acid formation consisting of flooding the tunnel with a liquid mixture of carbon dioxide and ammonia to displace the air in the workings. The tunnel would then be slightly pressurized to force the carbon dioxide into the cracks and fissures. By eliminating the oxygen in the mine voids, the acid-formation processes would be halted. In the proposed process, existing mine water is removed and treated until the water in the mine has become neutral and metal-free. At this point, the mine would be plugged and permitted to flood.

EPA Response. EPA appreciates TUSCO's proposed remedy for the Yak Tunnel. However, in evaluating this remedy against EPA's criteria for implementability and effectiveness, the following concerns have been raised: (1) the solubility of carbon dioxide in water is high and will produce carbonic acid; (2) the faults, fractures, void space, drill holes and other openings will make it difficult to keep sufficient carbon dioxide (liquids) in the system; and (3) this is an unproven technology that will require substantial research and development prior to use at a Superfund site.

4. BACTERIA TREATMENT

Proposal. TUSCO also commented that recent developments have been promising in handling the thiobacillus ferooxidan bacterium. TUSCO suggested that EPA look into these developments and requested time to present information to the Agency.

EPA Response. EPA acknowledges that there are emerging technologies for treating the bacteria that enhances the generation of acidic water. Some of these technologies were evaluated in Section 5 of the FS. However, since EPA has revised its proposed remedy to include tunnel plugging, bacteria treatment is not necessary to provide protection of public health and the environment. EPA would be willing to meet with TUSCO to discuss bacteria treatment for possible consideration in subsequent operable units.

5. POLYMER INJECTION

Proposal. The Department of the Interior noted that EPA considered only conventional methodologies in its FS for minimizing recharge to the underground workings. The Department suggested that innovative technologies, such as injection of polymers or other cohesive agents to seal fractures and flow paths, be considered as well.

EPA Response. These types of sealants were considered in various grouting alternatives analyses. These actions involve extensive drilling and injection of material to reach the numerous voids and fractures. These actions would thus create significant adverse environmental impacts and be very costly. The use of polymers or sealing agents will be retained for consideration during the remedial design of the water control measures.

6. ELECTROCOAGULATION

Proposal. The Acid Mine Drainage Action Group (AMDAG) proposed the use of electrocoagulation as an innovative technology for treating acid drainage. Acid drainage would be treated with this process without any other pre- or posttreatment such as pH adjustment or filtration. According to AMDAG, initial test work indicates that the generated sludge may be nonhazardous.

EPA Response. EPA has modified its proposed remedy to include tunnel plugging, which will minimize the amount of effluent requiring treatment. EPA has selected a lime treatment system for interim treatment. However, EPA is interested in obtaining additional information on this emerging technology so that it could be further evaluated during a subsequent operable unit. AMDAG presented initial test work data for this process, but EPA also needs process design, operation, maintenance, and cost information for further evaluation of the proposal.

7. RESTORATION OF THE YAK TUNNEL

Proposal. Leadville Mining and Milling Corporation proposed that the Yak Tunnel be kept open for the drainage and ventilation purposes for which it was designed. The company's tunnel plan, as a cost-saving measure, would require restoration to an opening of 6 feet by 8 feet, room enough for a small haulage locomotive necessary to conduct future maintenance or repair. The company estimates that some of the worst areas in the tunnel could incur direct costs of approximately $1,000 per foot for rehabilitation. However, work in most of the tunnel would not be this expensive. The proposal includes installing track and a suitable flume under the track to convey water out of the tunnel. Laterals from the tunnel that are not in use would be sealed with concrete walls that had removable doors in case future access or ventilation is needed.

EPA Response. Conceptually, many of these suggestions are implicit in Alternatives 5 and 7. EPA has selected tunnel plugging as its revised remedy because it will reduce the amount of acid drainage needing treatment. Flooding the sulfide zone through tunnel plugging will reduce the production of acid mine drainage.

8. REPLACE TUNNEL

Proposal. Robert L. Elder and other Leadville residents suggested that it may be more cost-effective to construct a new tunnel rather than rehabilitate the existing Yak Tunnel.

EPA Response. Construction of a new tunnel would raise the same concerns about cost and safety as Alternative 5, but would have greater environmental impact. Construction of a new tunnel would simply perpetuate the production of acid mine drainage. The selected remedy includes tunnel plugging to halt the drainage.

9. SEEPAGE CONTROL

Proposal. Hecla proposed a variation on Alternative 2 that would include seepage control measures as an alternative to a permanent treatment plant. This proposal would include a monitoring program to detect surface seepage and a sealing/grouting program to abate seeps. In addition, seeps could be collected, extracted, and reinjected into the mine workings. If seepage to the California Gulch alluvium is determined to be a problem, a system of extraction wells and/or ditches could be used to intercept the seepage and pump it back into the mine workings.

EPA Response. The remedy selected by EPA incorporates most of the concepts proposed by Hecla. The primary difference is that the selected remedy will treat and discharge problem seepages while Hecla proposed that seepages be collected and reinjected into the underground workings.

EPA selected the treat-and-discharge option because it provides for a direct and positive control on ground water levels (and seeps) in the area behind the portal plug. If water is reinjected behind the portal plug, there may be no net reduction in water levels and seepage would continue. On the other hand, reinjection of the water behind the Ibex-Irene or the Resurrection plug may be more appropriate provided it does not lead to unacceptable levels of contaminated seepage from these workings to the neighboring regional ground water bodies such as the area around Elkhorn Shaft, Leadville's water supply. EPA recognizes that this reinjection concept has merit and will consider it further during the design phase of the selected remedy.

10. PUMPING AND TREATMENT

Proposal. ASARCO identified an alternative that would include tunnel plugging, collection by pumping and treatment, and discharge. ASARCO noted that relatively simple and inexpensive pumping wells could be completed in the old workings and then used to control water levels in the tunnel and to remove water at the desired rate. ASARCO also noted that water control by pumping is presently being practiced successfully at the Leadville Drainage Tunnel.

EPA Response. These concepts have been incorporated in the selected remedy. One difference is that the selected remedy incorporates a shaft or an extraction well for pumping water from behind the portal plug instead of the wells suggested by ASARCO. The shaft

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could serve a dual purpose since it could provide an easy and safe access for construction of the portal plug and also be used for pumping. However, EPA agrees that the ASARCO suggestions have merit and will continue to investigate the pump well installation alternative during the design phase of the selected remedy.

Proposal. Leadville Corporation also proposed a pump-and-treatment system as part of its remedy. This proposal includes pumping of water from behind the Resurrection plug, treatment, and discharge to Big Evans Gulch while mining operations continue. When mining ceases, Leadville Corporation would allow water to rise behind the plug.

EPA Response. EPA has not selected this component of Leadville Corporation's remedy as part of the selected remedy. EPA does not anticipate that it will be necessary to pump and treat water from behind the Resurrection plug. If monitoring indicates that adverse impacts on ground water may occur as a result of the remedy, pumping and treatment may be implemented as a contingency, if appropriate. Although pumping and treatment is not part of the remedy, Leadville Corporation may on its own initiative pump and treat in accordance with all applicable regulations as part of its mining operations.

11. INTERIM TREATMENT

Proposal. Hecla proposed that EPA consider plugging as proposed by ASARCO, in conjunction with an interim treatment system reduced in scope to include basic lime addition and a settling pond followed by discharge to the diversion channel.

EPA Response. This proposal is similar to the selected remedy.

PUBLIC HEALTH AND ENVIRONMENTAL ASSESSMENT

EPA received extensive critical comment from ASARCO, Hecla, and Resurrection regarding the "Public Health and Environmental Assessment" section of the FS. These comments are summarized below.

1. Hecla commented that EPA failed to perform an endangerment assessment sufficient to support its preferred alternative as required by EPA guidance. Resurrection also noted that an endangerment assessment was not performed.

EPA Response. Under EPA's "Guidance on Feasibility Studies Under CERCLA," dated June 1985, an FS is to include a discussion of the nature and extent of problems at a site, including the types of releases, affected media, movement of contamination, and exposures. The "Public Health and Environmental Assessment" section of the FS serves this function. An "Endangerment Assessment" is prepared to support an action under Section 106 of CERCLA, but is not necessarily part of an FS. On page 1-6 of EPA's "Guidance on Feasibility Studies Under CERCLA," it is noted that an Endangerment Assessment can be performed at any point in the RI/FS process, including after the FS is complete.

2. There were numerous comments critical of the overall approach and of specific aspects of the "Public Health and Environmental Assessment."

   EPA Response. As outlined in the Record of Decision, the Yak Tunnel discharges more than 200 tons of metals per year that contribute to contamination of surface water, ground water, and sediments. EPA has sufficient basis to select a Yak Tunnel operable unit remedy to abate this release. In conjunction with future operable units, EPA plans to prepare an Endangerment Assessment in accordance with all applicable guidance that will address the threats to public health and welfare and the environment associated with the entire site. EPA anticipates that this Endangerment Assessment will address the majority of concerns raised by commenters.

3. ASARCO provided information and data on aquatic life and aquatic habitat in the upper Arkansas River to support its comment that re-establishment and maintenance of a productive trout fishery should be the cleanup goal for the Arkansas River.

   EPA Response. EPA will carefully evaluate this information and data, as well as information from other sources, in preparing the Endangerment Assessment and in subsequent operable unit studies.

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ASARCO, Hecla, Leadville Corporation, Resurrection and others raised comments and concerns about the degree of

Appendix C of the Record of Decision contains more detailed information on ARARs.

1. ASARCO stated that EPA did not comply with EPA's "Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements," which appeared in the August 27, 1987, Federal Register, with respect to the timing of identification and consideration of ARARs.

   EPA Response. The Phase I RI report and the FS were released, respectively, in May and June 1987, before EPA issued the interim ARARs guidance. Nevertheless, EPA considered ARARs during both the remedial investigation and feasibility study. The Phase I RI contains a discussion of maximum contaminant levels (MCLs) and ambient water quality criteria (AWQC) and includes tables comparing MCLs and AWQC to site sampling data. In the FS, EPA identified a range of alternatives and screened them based on factors including their anticipated attainment of ARARs.

2. Two commenters discussed cleanup goals. Hecla questioned what the cleanup goals for the Arkansas River are (e.g., restoration to premining condition or achieving highest quality and practicably attainable use). Hecla also stated that EPA's cleanup standards are unsupported because they have no direct relevance to the ultimate cleanup goals for the Arkansas River. ASARCO stated that the ARARs should be those that allow the Arkansas to achieve its highest designated use classification.

   EPA Response. Under Section 121 of SARA, EPA must select remedies that assure protection of human health and the environment. To the extent that hazardous substances, pollutants, or contaminants will remain onsite, the remedy must attain a level or standard of control that at least attains federal and state ARARs. EPA and the State have identified chemical-specific ARARs as discussed in Appendix C of the FS and Appendix C of the Record of Decision. These ARARs include State water quality standards designating uses of the Arkansas River for Class 1 cold water aquatic life, secondary contact recreation, and agricultural uses.

3. Two commenters questioned whether it was appropriate to establish ARARs for an operable unit. Resurrection asserted that interaction between surface water and ground water, combined with the commingling of contaminants from man-made and natural sources

precludes the establishment of ARARs for the operable unit. Hecla stated that it is inappropriate to set discharge limitations for the treatment facility in the absence of a complete site cleanup program since the ultimate effect of other sources on water quality in the Arkansas is unknown.

EPA Response. Under Section 121 of SARA, ARARs must be established for remedial actions. This requirement applies, even if the response action is being conducted in operable units. Interactions between surface water and ground water and the nature and extent of contamination may influence which requirements are considered ARARs, but ARARs must still be established. The selected remedy includes an interim treatment facility for which technology-based effluent limitations are an action-specific ARAR. This operable unit is designed to address a major source of contamination identified in the Phase I RI. The effluent limitations will be re-evaluated when a more comprehensive treatment alternative is developed in a subsequent operable unit.

4. ASARCO commented that EPA failed to consider the use of "alternate contaminant levels" as cleanup standards pursuant to Section 9621(d)(2)(B)(ii) of CERCLA as required by EPA's "Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements."

   EPA Response. EPA assumes that ASARCO referred to "alternate concentration limits" as discussed in the CERCLA provision cited. This provision refers to alternate concentration limits for hazardous constituents in ground water under the Solid Waste Disposal Act. Since the Yak Tunnel operable unit is not designed as a ground water cleanup measure, EPA views this provision as neither applicable nor relevant and appropriate.

5. ASARCO, Hecla, and Leadville Corporation expressed concern that the cleanup criteria did not fully consider site-specific conditions in the Leadville area. ASARCO noted that pursuant to EPA's "Interim Guidance on Compliance with Applicable or Relevant and Appropriate Requirements," ARARs identification depends on the specific chemicals at the site, the particular remedial actions, and site characteristics.

   EPA Response. Under the interim ARARs guidance, requirements may be relevant and appropriate if they address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. This can be determined by comparing the characteristics of the remedial action, the hazardous substances in question, or the physical circumstances of the site. EPA and the State identified ARARs for the specific remedial actions considered for this operable unit. The ARARs relate to cleanup of metals in contaminated media addressed by this operable unit. EPA and the State took into account the physical characteristics of the site, including surface water and ground water interaction and the location of wetlands and floodplains, and historic resources.

6. ASARCO stated that it cannot determine the relevance or appropriateness of MCLs as an ARAR until the boundaries of the operable unit are defined, the points of exposure outside the boundary are defined, and the point of compliance is identified.

   EPA Response. The rationale for identifying MCLs as an ARAR for surface water is described in Appendix C. The pathways of exposure to metals discharged from the Yak Tunnel are described in Section III of the Record of Decision. EPA does not believe that it is necessary to define the "boundaries" of the operable unit, as an operable unit consists of response actions. Figures 5 and 6 in the Record of Decision show the proposed locations of components of the selected remedy. Section 121 of SARA does not provide for a "point of compliance" for ARARs, so MCLs are considered ambient standards in surface water.

7. ASARCO asserted that EPA ignored the use of institutional controls in preventing use of ground water for drinking water downgradient from the Yak Tunnel.

   EPA Response. Institutional controls were evaluated as Alternative 10 in the FS.

8. ASARCO stated that the AWQC are not relevant and appropriate as they would dictate cleanup in excess of background levels. Leadville Corporation commented that both MCLs and AWQC may not be relevant or appropriate or even attainable given the potential for higher background levels of metals in mineralized areas. Hecla and Resurrection were also concerned about background levels, as were citizens at the public meeting in Leadville.

   EPA Response. Under Section 121(d)(2)(A) of SARA, remedial actions must require a level or standard of control that at least attains AWQC where such requirements are relevant and appropriate under the circumstances of the release. Section 121(d)(2)(B)(i) describes the factors that EPA must consider in determining whether AWQC are relevant and appropriate. This determination is described in Appendix C of the Record of Decision. EPA has found no data documenting premining metals concentrations in California Gulch or the Arkansas River. Since EPA has no data documenting premining water quality, EPA could not conclude that the AWQC would require cleanup in excess of background levels. EPA recognizes that nonpoint sources of metals, some of which may be naturally occurring, may influence whether or not cleanup goals can be reached.

9. ASARCO presented geochemical modeling and information on the Red Dog ore deposit in Alaska and suggested that premining water quality was in excess of certain MCLs and AWQC. At the public meeting, Mr. Will Beach also noted a comparison between the Red Dog deposit and the Leadville Mining District and asked if Red Dog were a Superfund site.

   EPA Response. EPA recognizes that surface and ground water quality in certain mineralized areas does not meet MCLs and AWQC even though no land disturbance has occurred. The area around the Red Dog deposit is one example. Red Dog has not been designated as a Superfund site. Under Section 104(c)(3)(A) of SARA, EPA cannot remediate a release or threat of release of a naturally occurring substance in its unaltered form, or altered solely through naturally occurring processes or phenomena, unless a public health or environmental emergency exists that will not otherwise be addressed in a timely manner. The California Gulch site can be distinguished from Red Dog in that the Leadville area has been extensively altered by mining and minerals processing activities for more than 125 years.

   Nevertheless, EPA recognizes that establishment of cleanup levels in mineralized areas poses special challenges. For this reason, EPA is currently studying this issue and plans to solicit input from the public.

10. ASARCO performed equilibrium geochemical calculations to demonstrate that premining surface and ground water quality contained elevated metal concentrations.

   EPA Response. EPA acknowledges the geochmical modeling performed by ASARCO. However, the equilibrium geochemical calculations performed by ASARCO are inappropriate for determining premining background levels. The "total" natural system is very seldom in equilibrium and the water quality is a function of complex time dependent reactions and the various types of rock and soil that the water may encountered. The metal values predicted by ASARCO could at best only be used to indicate upper limits for a few localized pockets of slow moving ground water.

11. Hecla asserts that EPA advocates adoption of aquatic life standards to restore or maintain fish population in California Gulch without any evidence that fish survived there under premining conditions.

    EPA Response. The AWQC are established to protect freshwater aquatic life, not just fish. EPA plans to conduct a use attainability analysis of California Gulch in a future operable unit to determine what uses, including aquatic habitat, may be appropriate for California Gulch.

12. ASARCO commented that the State's "basic standards" are not applicable as cleanup standards below background levels or to that portion of existing metals levels in environmental media that is attributable to natural background.

    EPA Response. Under Section 3.1.11 of the Basic Standards and Methologies, the State's "basic standards" apply to introduction of "substances attributable to human-induced discharges" to waters of the State (5 CCR 1002-8). These standards are not limited by background levels.

13. ASARCO and Leadville Corporation questioned whether aquatic water quality criteria are appropriate cleanup standards since aquatic species can adapt to higher concentrations of metals. ASARCO stated State water quality standards reflect local acclimation of trout to metals.

    EPA Response. State water quality standards that reflect an acclimation factor are not necessarily more appropriate than Federal water quality criteria. First, both the Federal and State water quality criteria/standards take into account, to some degree, the fact that acclimation may influence tolerance of aquatic organisms to some metals. Second, several factors normally influence tolerance of aquatic organisms to metals, so the fact that some species may be more tolerant to a few metals because of prior acclimation should not be overemphasized. Third, prior acclimation has been reported to influence tolerance to a few metals but acclimation may have no influence on tolerance to several metals common in the California Gulch and Arkansas River. Finally, State standards in some segments of the Arkansas River are more stringent than the Federal criteria, not less stringent.

14. ASARCO suggested that cleanup of the Yak Tunnel discharge could result in fish kills resulting from exposure of nonacclimated fish to periodic runoff from other highly mineralized areas.

    EPA Response. Aquatic ecosystems are dynamic systems that are influenced by a multitude of factors. The removal of one source of metals, even though it is considered a principal source, is not likely to present an abrupt shock factor because of residual metals in sediments and other media. There are also several other sources of metals in the area that would reduce the likelihood of development of a nonacclimated segment of the fish population. Prior acclimation may influence the tolerance to only a few metals in the system, not to all. Fish will generally move out of a particular stream section if the environmental conditions are outside of their preference ranges.

15. ASARCO suggested that AWQC are significantly more stringent than necessary to re-establish and protect aquatic life in the Arkansas River downstream from the confluence with California Gulch and are thereby overprotective. ASARCO further noted that the AWQC will be more stringent than necessary because they are calculated to protect 95 percent of freshwater aquatic species from toxic effects.

    EPA Response. EPA disagrees with this comment. As discussed above, EPA identified the AWQC as an ARAR in accordance with statutory requirements. Nevertheless, EPA plans to undertake further work during future RI/FS activities to determine whether or not it would be appropriate to refine this ARAR in subsequent operable units. EPA disagrees that AWQC are more stringent than necessary in terms of the percent of species that the standards are designed to protect. Aquatic species exhibit a wide range of susceptibility to toxicity and it is appropriate to protect sensitive species.

16. ASARCO commented that the AWQC are highly influenced by data for species more sensitive than the brown trout and benthic macroinvertebrate communities which are found in streams with elevated metals concentrations.

    EPA Response. The AWQC, in general, are not highly influenced by data for species more sensitive than the brown trout and local benthic macroinvertebrate communities. In most cases, the AWQC are based on data from a range of species, including fish, benthic macroinvertebrates, and plants. Also, the criteria are based on a large data set whenever appropriate data are available.

17. ASARCO stated that it is impossible to establish numerical cleanup goals to protect fisheries because of limited data on metals toxicity in resident species. ASARCO also noted that there is insufficient data on acute and chronic toxicity to resident species to recalculate the water quality criteria on a site specific basis.

EPA Response. The data bases available to and used by the scientists who established the Federal AWQC and State standards are not any less appropriate for the Arkansas River than for many other site-specific locations. The scientific community, as a rule, would like site-specific data whenever possible to use as a basis for making decisions. However, it is certainly possible and acceptable to make decisions using the best set of available data. EPA and the State of Colorado may consider additional site-specific studies to refine cleanup goals.

18. ASARCO commented that cleanup criteria should be based on dissolved metals concentrations and that there is no good reason to use the total recoverable or acid soluble analytical methods upon which the AWQC are based.

EPA Response. Metals of concern at the California Gulch Site may exist in a variety of forms, and definitive information on the relative toxicities of the different forms is not always available. Therefore, no single available analytical procedure is known to accurately reflect toxicity for a range of species under varying environmental conditions. The AWQC were formerly expressed in terms of total recoverable metals (EPA Water Quality Criteria 1980 and 1986), but more recently, EPA has based the AWQC on the acid soluble analytical method. The advantages of using the acid soluble analytical method are presented in more recent water quality criteria documents (for example, lead and cadmium AWQC documents, 1984). The total recoverable measurement is probably too rigorous in some situations because it may measure some forms of metals, such as lead occluded in minerals and clays, that are not toxic and are not likely to become toxic under natural conditions. On the other hand, dissolved metals concentrations may exclude some forms of metals, such as carbonate and hydroxide precipitates, that could be toxic or become toxic under natural conditions. At the California Gulch site, there could be a significant portion of the toxic or potentially toxic forms of some metals that would be removed during the field collection of a sample to be analyzed for dissolved metals. Therefore, the dissolved metals procedure could underestimate the toxicity of the aquatic system.

19. Hecla questioned what habitat limitations might prevent the Arkansas River from achieving its highest quality and practicably attainable use.

    EPA Response. In its comments on the FS and proposed remedial action plan, ASARCO presented information on the physical habitat for trout of the Arkansas River downstream from California Gulch and concluded that habitat quality is mixed, but that some areas appear to be good to very good. EPA plans to undertake further assessment of aquatic habitat in subsequent operable units.

20. ASARCO recommended that the re-establishment and maintenance of a productive trout fishery should be the cleanup goal. ASARCO proposed, as an alternative to numerical cleanup standards, a biologically-based approach to re-establish and maintain water quality that supports a productive trout fishery. ASARCO suggested using a trout habitat evaluation model to define the carrying capacity for various river segments. This model could be used to derive trout population goals for the various segments. Cleanup of sources would be phased to achieve a predetermined degree of cleanup, with elimination of sources of the metals and use of the most cost-effective metals removal strategies first. The success of the cleanup would be measured both by biomonitoring and by annual population estimates. Once the acceptable trout population levels were reached, stream standards could be established and used for compliance monitoring.

    EPA Response. EPA agrees with the concept of a biological approach to measure the success of cleanup measures. Under Section 121(d) of SARA, remedial actions must assure protection of human health and the environment. EPA plans to use biomonitoring and biological sampling as part of the remedial action in subsequent operable units to ensure that the remedial action is protective. EPA does not view this as a substitute for numerical cleanup goals that are necessary for design and implementation of remedies.

21. There was little public comment on location-specific or action-specific ARARs. Two commenters--the Department of the Interior and the Colorado Historical Society--emphasized the historical significance of the Yak Tunnel.

    EPA Response. As discussed in Appendix C of the Record of Decision, the requirements of the National Historic Preservation Act will be followed.

COSTS

1. Alpenglow Excursions and Mr. Ed Moats of Leadville questioned how the cost estimates for the alternatives considered, particularly the proposed alternative, were derived.

EPA Response. CERCLA, the NCP, and EPA's "Guidance on Feasibility Studies Under CERCLA," dated June 1985, describe how cost estimates are to be developed. These estimates include both capital costs and costs for operations and maintenance for the entire period during which such activities will be required. In accordance with EPA guidance, costs are estimated based on vendor estimates, estimates for similar projects, and standard costing guidance. The cost estimates for alternatives for the Yak Tunnel operable unit are referenced in the cost appendixes of the FS. The Yak Tunnel rehabilitation cost estimates were based on time and material estimates and experience in mines in Canada and the western United States. The cost estimate for the selected remedy is set forth in Appendix B of the Record of Decision.

2. Alpenglow Excursions, Mr. Moats, and Mr. Frank Paden of Leadville questioned how costs could be estimated for a remedial action that would include operations and maintenance "in perpetuity." These concerns ranged from incredulity at the timeframe being considered to confusion about how costs could be estimated into an endless future. The Department of the Interior and Hecla also questioned whether the long-term costs associated with treatment in perpetuity had been adequately considered.

EPA Response. "In perpetuity" means forever. However, because the remedy would leave contaminants onsite, EPA must review the remedial measures no less often than each 5 years. Thus, EPA could implement a new technology at some future date to minimize or eliminate the need for perpetual treatment. Perpetual costs were calculated through the use of a present-worth analysis. Under EPA guidance, this type of analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the present. To conduct the analysis, assumptions must be made about the discount rate and the period of performance. The period of performance for perpetual tunnel maintenance and treatment is infinity. Through use of appropriate mathematical equations, the present value of performance into infinity can be calculated. It must be recognized, however, that this value is not the total cost of the alternative.

3. Alpenglow Excursions, the Lake County Environmental Task Force, Mr. Carvel Stout, Mr. Robert Dechant, Hecla, the State of Colorado, and AMDAG questioned details on cost and time estimates for rehabilitating the Yak Tunnel.

EPA Response. Cost estimates for tunnel rehabilitation were made based on professional judgment by engineers experienced in tunneling and in tunnel rehabilitation. Data on the tunnel conditions provided by ASARCO were used as the basis for the cost estimates. Based on current knowledge of the tunnel, it was estimated that more than 8,000 feet would require timber or steel set rehabilitation. In addition, a 20 percent contingency factor was included to allow for rehabilitation of junctions with laterals.

4. Alpenglow Excursions suggested that there may be extensive cost and schedule overruns.

   EPA Response. EPA shares this concern about cost and schedule overruns and will work to ensure that remedial action is both expeditious and cost-effective. Prior to and during remedial design, the project schedule and cost estimates will be reviewed and revised, if appropriate.

5. Mr. Dechant, Mr. Stout, Hecla, and the Department of the Interior commented that the cost estimates for Alternatives 5 and 7 were too low, particularly for operation and maintenance for water treatment (Alternative 5) costs, capital, operations and maintenance for plugging/treatment (Alternative 7), and sludge disposal. The Department of the Interior suggested further evaluation of recharge reduction options to reduce the long-term costs of treatment and sludge disposal.

   EPA Response. The cost estimates were developed in accordance with EPA guidance using the best available information. Further refinement of cost estimates may occur during remedial design. The selected remedy incorporates tunnel plugging, seepage control, and water control measures to minimize the need for water treatment and sludge disposal. During the design phase, a more detailed evaluation of the water control aspects will be completed.

6. Mr. E. H. Queener of Leadville asked if the consumer would help pay for the cleanup.

   EPA Response. As described in the Record of Decision, EPA has filed an action against parties responsible for site contamination, including the Yak Tunnel discharge. EPA is seeking to have responsible parties undertake and bear the costs of cleanup. EPA may also undertake the remedy itself using the Superfund and seek recovery of its costs from responsible parties. If responsible parties pay for the cleanup, consumers may eventually indirectly contribute to cleanup costs through higher prices or other means. To the extent that the Superfund is not reimbursed by responsible parties, those taxpayers who contribute to the Superfund would bear the cost.

7. AMDAG commented on the appropriateness of the sludge disposal costs, particularly if the sludge is a hazardous material.

   EPA Response. The selected remedy includes plugging, seepage control, and water control measures that will substantially decrease the amount of any sludge produced. To the extent that the interim treatment facility generates sludge, it will be stored or disposed of in accordance with the ARARs described in Appendix C of the Record of Decision. It is difficult to estimate interim sludge disposal costs with precision until further information about the quantity and characteristics of the sludge is available.

8. AMDAG questioned the adequacy of insurance cost estimates in the FS.

   EPA Response. The annual operation and maintenance costs presented in Appendix L of the FS include a line item for insurance, taxes, and licenses. This line item covers typical accident insurance and local taxes. In addition, the costs for licenses may be minimal as Federal, State, and local permits are not required for actions conducted entirely onsite. As such, EPA believes that the 2 percent line item estimate is reasonable.

9. Mr. Crocker commented that focus on the Yak Tunnel implies that combinations of Yak Tunnel and tailing pile cleanups, which could be less costly, are dismissed out-of-hand. He stated that correct least-cost procedure would require that incremental costs be equated across control measures within an operable unit and across operable units.

   EPA Response. A remedy may be conducted in operable units, provided the response action is cost-effective and consistent with a permanent remedy. As discussed previously, the selected remedy meets both of these requirements. Given the discrete nature of the response action, EPA does not believe that simultaneous consideration of response actions for tailings piles or other site features would result in a more cost-effective remedy. The selected remedy provides a flexible approach to integration with future operable units.

10. Mr. Crocker also commented that, aside from sludge disposal, EPA supplied no quantitative treatment of the cost associated with the environmental impacts of its considered alternatives.

    EPA Response. EPA evaluated alternatives and selected a remedial action to minimize environmental impacts associated with the selected remedy. For example, the remedy includes a monitoring program and contingency measures to identify and mitigate any impacts. In addition, EPA identified long- and short-term impacts associated with the selected remedy. The costs for these measures are included in the cost of the alternative through alternatives development and design and siting factors.

11. Leadville Corporation commented that its proposal or the ASARCO proposal should be implemented if either provides a less costly alternative.

    EPA Response. Under CERCLA, the NCP, and EPA guidance, EPA must evaluate the effectiveness and implementability of each alternative, as well as its cost. Any alternative selected must meet the requirements of Section 121 of SARA. EPA cannot simply select the least costly alternative identified.

12. Hecla commented that EPA's flawed remedy selection process led it to ignore long-term maintenance costs and that, as a result, the selection process is legally defective.

    EPA Response. As discussed above, EPA calculated the costs of long-term operation and maintenance during the detailed analysis of alternatives. EPA also evaluated the present value of these alternatives. The selected remedy has the potential to minimize long-term maintenance requirements.

13. Hecla asserted that the cost-effectiveness analysis required by the NCP mandates EPA to consider costs in terms of remedies that meet applicable or relevant cleanup goals. Hecla further stated that EPA must establish reasonable cleanup goals so that cost factors may be given the detailed analysis they deserve in light of the most effective technology for obtaining these goals. Hecla concluded that EPA failed to set reasonable cleanup goals and standards for the California Gulch site.

EPA Response. Under Section 121 of SARA, EPA must select remedial actions that are protective of human health and the environment. In addition, as discussed above, remedial actions that leave any hazardous substances, pollutants, or contaminants onsite must attain ARARs at the completion of the remedial action. This is the degree of cleanup required by statute. In the FS, EPA analyzed both cost and ARARs attainment as required by SARA and the NCP in the initial screening and detailed analysis of alternatives. Section VI and Appendix C of the Record of Decision describe how the selected remedy meets these requirements.

14. Mr. Larry Tanglen and Mr. Henry Harelson questioned if EPA had estimated costs for Alternatives 5 and 7 and if the costs included treatment plant operation and maintenance, including sludge disposal.

EPA Response. The estimated cost for Alternatives 5 and 7 are presented in the Yak Tunnel FS. Sludge disposal costs are included in the estimates. The estimated cost of the selected remedy is presented in the Record of Decision.

TECHNICAL ISSUES IN THE FS AND PROPOSED PLAN

Commenters raised technical issues and concerns regarding information contained in the FS and proposed remedial action plan.

1. The Department of the Interior stated that it has information indicating that the geological faults shown in the FS figures and discussed in the text were mislabeled.

EPA Response. S. F. Emmons, the geologist whose 1886 and 1927 studies of the Leadville area are considered the most complete and accurate, was the source for the information used in the FS. EPA would be interested in studying any additional information the Department has for the Leadville area.

2. Several commenters, including Alpenglow Excursions, the Lake County Environmental Task Force, and Hecla were concerned that EPA has limited data on the condition of the Yak Tunnel and the hydrology of the site.

EPA Response. The Yak Tunnel FS used all information available from existing sources and obtainable from ASARCO. Some of the information presented by ASARCO in their response to the FS has been used in development of the selected remedy. Additional information on the condition of the Yak Tunnel and hydrology of the site will be collected during the remedial design phase.

3. Marsh & Associates questioned the absence of any radionuclide investigation at the California Gulch site in general, and at the Yak Tunnel in particular.

   EPA Response. Radionuclides will be investigated in a subsequent operable unit.

4. Hecla pointed out the uncertainties concerning surface water and mine hydrology relating to the Yak Tunnel and noted that these uncertainties must be taken into account in remedy selection and development of cost estimates.

   EPA Response. EPA acknowledges that the geology and hydrology of the Yak Tunnel area are complex and that uncertainties exist. EPA has taken a conservative approach in developing the selected remedy. A monitoring program and contingency plans are integral parts of this remedy. Additional data will be obtained during the remedial design to minimize the uncertainties associated with implementation of the selected remedy. Uncertainties were taken into account during development and selection of remedies and in cost calculations.

5. Hecla stated that due to the lack of ground water data for the tunnel, many of EPA's conclusions in the FS and proposed plan "cannot be supported by fact." ASARCO pointed out that "limited data were available to EPA" and that "the effect that partial plugging may have on the mine workings and seepage cannot be predicted reliably." On the other hand, ASARCO also stated that there is extensive data on the underground workings and that further studies and additional data are not necessary.

   EPA Response. EPA again acknowledges the complex nature of the Yak Tunnel system. However, all available ground water data and extensive historical information on the Yak Tunnel were used to develop a conceptual model of the ground water system associated with the Yak Tunnel. EPA believes that this model was sufficient to develop and evaluate remedial alternatives. The selected remedy accounts for potential limitations in the model and contingency plans have been developed in case unanticipated problems occur.

   Based on review of information made available by ASARCO and other parties, EPA believes additional information will be necessary to complete the design of the selected remedy. The material made available by ASARCO is incomplete and does not always include information on mine workings location relative to the surface. There is very little, if any, information on rock conditions, both from a strength or ground water flow point of view.

6. The State of Colorado noted a reference in Section 3 of the FS that, due to the lack of data, contamination of deep ground water systems is not considered. The State would prefer that a short discussion of the implications of this exclusion on the FS be included.

   EPA Response. The flooded mine zones of the Yak Tunnel may currently contribute contaminated ground water to the deep ground water system located east of the Pendry fault. EPA evaluated the effects of alternatives considered in the detailed analysis section of the FS on the deep ground water system and found that minimal increases in flow to this system would occur.

7. The State of Colorado commented that the statement in Section 8 of the FS that there "should be an improvement in fish habitat as a result of a cleanup" is unsubstantiated. The State would prefer a more detailed qualitative and quantitative assessment of the anticipated aquatic habitat improvements.

   EPA Response. To the extent that water chemistry is a limiting factor for aquatic life, any improvement in water quality should result in an improvement in aquatic habitat. Further information on aquatic life and potential habitats will be addressed in future California Gulch site studies.

8. The Department of the Interior commented that the FS is divorced from surface materials deposited in and along California Gulch. The Department noted that release of treated water to California Gulch may affect downstream conditions favorably or adversely. Specifically, it was stated that treated water may flush accumulated precipitate from the streambed and that water-sediment interactions would increase dissolved metal concentrations through adsorption, and would certainly increase total metal concentrations. The Department further noted that treated water would improve the quality of ground water in the alluvial aquifer.

   EPA Response. EPA recognizes that chemical interactions will occur between the treated water discharged from the interim treatment plant and the gulch sediments. However, the selected remedy will significantly reduce the total metal load to the California Gulch system and, thus, will constitute a key component in the overall site remedy. Nevertheless, EPA recognizes that remobilization may be greatly affect the quality of shallow ground water and surface water along California Gulch. Additional information concerning remobilization of metals is being analyzed as part of the Phase II RI report for the California Gulch site.

9. Hecla commented that the FS ignores the institutional issues associated with operating treatment and disposal facilities in perpetuity. Hecla also stated that the FS ignored sludge disposal and asserted that the remedy would increase rather than decrease the amount of hazardous waste in the environment.

   EPA Response. EPA is aware of the problems involved with a remedial action that must be operated in perpetuity. EPA has modified its remedy to include tunnel plugging, which will minimize the amount of sludge requiring disposal and eliminate the need for perpetual tunnel maintenance. EPA disagrees that the remedy will increase the amount of hazardous waste in the environment. The tunnel discharge now distributes metals widely throughout the environment and contributes to widespread contamination. Both the preferred alternative and the selected remedy provide for collection, treatment, and disposal of sludge, which will contain and minimize dispersion of metals in the environment. The questions raised by Hecla regarding implementation of the remedy have been addressed in the Record of Decision. EPA has filed an action under CERCLA seeking to have defendants implement and maintain the remedy.

10. EPA's Hazardous Waste Research Laboratory commented that backfilling mine voids with a permeable material such as mine tailings or quarry rock, as discussed in part in Alternative 1, would not isolate the sulfide zones from contact with water nor would it necessarily reduce the quantity of water moving through the mine voids. It was further commented that only if the mine voids were filled with an impermeable material would this approach be effective.

    EPA Response. EPA agrees with the above contention. It was for that reason that the backfilling by means other than a type of concrete were rejected during the development of alternatives in the FS. In the initial screening of alternatives, it was further recognized that even backfilling with grout may not be technically feasible, in that it may not be possible to fill all the mine voids.

11. The Department of the Interior commented that the effect of surface solids, which can be washed into the gulch during runoff periods, has not been considered carefully.

EPA Response. EPA agrees that surface solids (such as mine wastes, tailings, and soils) can be washed into California Gulch. These will be addressed in a subsequent operable unit.

12. The State of Colorado requested that the information concerning wetlands (paragraph 3, page 8-22) be clarified. The State noted that there appears to be misinformation on plant toxicity and remobilization of metals; plants that are metal-tolerant exclude or encapsulate metal ions and, therefore, are not affected by metal concentrations. The State also stated metal uptake often occurs in acidic conditions, and so the remobilization statement is confusing.

EPA Response. Some wetland plants that are metal-tolerant actively exclude metals from transfer into root and leaf structures. Other wetland plants uptake metal ions, storing them in rhizome and root structures and seasonally translocating them to aboveground vegetative structures. Similarly, some plants bind the ions to organic molecules within the plant structure and ions are immobilized in this manner. In general, evidence of plant toxicity has been linked to metal concentrations in the leaf material elevated beyond some threshold level, the latter dependent on the plant species and other ions present. Thus, in metal-tolerant perennial species that translocate metal ions, over several seasons ion accumulation in leaf tissue may exceed the tolerance limit.

Metal uptake by plants frequently occurs under acidic conditions because metal ions are more available in soil-water solutions. Metal ions are released from exchange sites in organic soil substrates and are dissolved from precipitated forms under acidic conditions. Remobilization thus refers to movement from the soil substrate, rather than movement out of the plants.

13. The State of Colorado commented that Appendix I of the FS states that ground water flow away from the mined area would be attenuated. The State questioned whether this statement is substantiated and suggested that, given the lack of specific knowledge about ground water movement in the area, statements about ground water should be qualified.

EPA Response. The nonmineralized geologic formations in the northern portion of the Leadville Mining District contain significant quantities of carbonate materials (limestone) that will buffer acidic water that might flow north from the mine workings. Therefore, it is unlikely any low pH water would affect the ground water in the upper Evans Gulch area. Acidic water that would flow toward upper California Gulch would be attenuated by nonmineralized geologic formations. Furthermore, the selected remedy incorporates a monitoring program to detect contaminant migration and contingency measures to deal with this migration should it occur and be judged to pose a health or environmental risk.

14. The State of Colorado noted that the assumption that roasted waste could be non-acid generating (page 5-23 of the FS) may be in error based on data from the Eagle Mine. The State suggested that this statement be revised to indicate that site-specific testing would be used to determine the nature of the material.

    EPA Response. Specific oxidation processes would be designed to fully oxidize the pyritic materials under consideration and produce a non-acid generating waste. If this option is pursued, laboratory testing would be undertaken to confirm design criteria of the oxidation process.

15. The State also commented that the screening of alternatives should consider the impacts and hazards associated with the implementation of those alternatives (i.e., roof falls or contact with slimes during tunnel rehabilitation). The State noted that such considerations could be important in the screening process and certainly must be considered in the design of the preferred alternative.

    EPA Response. Construction-related risks were considered in the detailed analysis portion (Section 8) of the FS. EPA agrees that safety conditions must be taken into account during remedial design.

16. AMDAG commented on the technical adequacy of the High Density Sludge (HDS)/ion-exchange treatment system in dealing with changes to influent conditions.

    EPA Response. EPA's proposed remedy has been modified to include an interim treatment system, so HDS treatment will not be used. Additional Yak Tunnel flow and chemistry information will be obtained during the remedial design phase. EPA agrees that additional work is required to design a treatment system that will properly perform under all circumstances.

17. AMDAG stated that EPA's proposed remedy did not adequately address surge events.

    EPA Response. EPA disagrees with this comment. Both Alternatives 5 and 7 incorporated provisions for ponds to collect surges that could occur during tunnel rehabilitation or after implementation of the remedy. EPA's selected remedy includes construction of surge ponds prior to any entry into the tunnel. In addition, the placement of three plugs within the Yak Tunnel will virtually remove the potential for surges after the plugs are constructed.

18. AMDAG stated that oxidation of sulfides will continue to be a problem unless conditions are modified to reduce the contact of atmospheric oxygen with sulfides.

    EPA Response. EPA agrees and has selected a remedy that will include a plugging component. Plugging will minimize the amount of sulfide oxidation, although some sulfides are expected to remain above the equilibrium ground water level after plugging.

19. AMDAG commented that with plugging, the ground water flow path may increase, and that plugging may significantly influence ground water chemistry.

    EPA Response. The selected remedy will influence ground water chemistry and flow. However, it is not expected to result in unacceptable ground water contamination in neighboring ground water regions. As an additional safeguard, the selected remedy includes a monitoring network to sample water chemistry and ground water levels in and around the flooded mine zones. If ground water impacts are identified, contingency pump-and-treat measures will be implemented.

20. AMDAG stated that the equations given by Stumm and Morgan (1981) do not reflect the time chemistry of acid generation from iron sulfide oxidation and presented an unpublished paper by Sullivan, Reddy, and Yelton (1987).

    EPA Response. EPA appreciates the additional information provided by AMDAG. Rate reaction calculations would only be relevant during the initial stages of the acid mine drainage formation. However, the system has already reached the state of acid generation.

21. Leadville Corporation agreed that the Diamond/Resurrection plug would reduce tunnel discharge from the Yak portal by 20 percent. However, Leadville Corporation stated that modeling undertaken on its behalf indicated that the metal mass loading would

probably increase rather than decrease as suggested in Appendix B of the FS. According to Leadville Corporation, this would be due to (1) elimination of the buffering capacity of water from the Resurrection area, and (2) loss of dilution by this water. Leadville Corporation suggested that these two effects should be taken into account when the proposed treatment plant moves from the conceptual to the design phase.

EPA Response. EPA agrees that the Resurrection plug alone, by cutting off entry of the higher pH water to the tunnel, could reduce the amount of sludge precipitation in the underground workings and, hence, increase the metal loads at the portal. However, the selected remedy employs at least two additional plugs located downgradient from the Resurrection plug and hence would prevent any increased metal load from exiting the tunnel. Furthermore, the total amount of metal that is dissolved from the mineralized rock would decrease as sulfide rock would be inundated by rising ground water.

22. Alpenglow Excursions and Mr. Rasmussen questioned how the sludge by-product from the treatment plant would be disposed of.

EPA Response. Sludge from the interim treatment facility will be stored in the surge ponds on an interim basis. A permanent disposal option will be implemented in conjunction with a future operable unit.

23. Alpenglow Excursions questioned what kind of provisions would be made for periods of malfunction or downtime due to floods, breakdowns, or human error. Hecla also commented on the potential for treatment plant upsets.

EPA Response. The surge ponds will be used to allow sufficient storage capacity for short-term repair of the treatment plant. Well-trained operating personnel will minimize operational mistakes, and a preventive maintenance program and proper plant design and construction will minimize breakdowns. The ponds will be protected from a 100-year flood by a system bypass and the plant will be located outside the floodplain area.

24. Alpenglow Excursions asserted that the Yak Tunnel, parts of which were constructed 100 years ago, would not accommodate modern mining equipment. Mr. Robert Dechant felt that many of the mining techniques discussed in the FS wouldn't be feasible for the Yak Tunnel.

EPA Response. The tunnel was constructed to be a nominal 8 feet square in size and to accommodate a locomotive engine and ore cars. Even with collapsed walls, the tunnel should be large enough to accommodate equipment considered for use in rehabilitation. Tunnel sections with collapsed walls or roof will be cleared out and reinforced to maintain access. Based on information available to EPA regarding tunnel conditions and modern mining techniques, EPA believes that tunnel rehabilitation and maintenance would be feasible. However, an alternate access method identified in the selected remedy is to construct a new shaft for construction of the portal plug. This shaft could later be used as part of the water level control system.

25. The Department of the Interior commented that the 2-million-gallon surge control pond, or wetlands, proposed for treatment of the acid drainage from the Yak Tunnel would create an attractive, but dangerous, habitat for migratory waterbirds. The Department suggested instead that a closed treatment system or other migration measures be used.

EPA Response. EPA's selected remedy will utilize the surge ponds on an interim basis to collect and treat surges from the tunnel that may occur during plug construction and as a treatment facility for acid drainage that may occur after plug installation. Wetlands treatment is not a part of the selected remedy. EPA recognizes that waterfowl may be attracted to the ponds and will work with the Department of the Interior and the Colorado Division of Wildlife to mitigate potential impacts on waterfowl.

26. Mr. Bates stated that overflows will result from any alternative using mine seals to partially (or totally) seal the Yak Tunnel. He noted that overflow points would have to be identified and measures included to collect and handle the overflow water, which would likely still be contaminated. He also stated that the full or partial plugging alternatives appear to assume no overflow of contaminated water and only address direct discharge from the tunnel portal.

EPA Response. In analyzing alternative remedial actions, EPA assessed the potential for ground water migration and surface seepage in both the Evans Gulch and California Gulch areas. Because of uncertainty associated with the effects of tunnel plugging, EPA has developed a monitoring plan and contingency measures to address possible seepage or ground water contamination. The contingency measures, as well as components of the remedy addressing seepage, are described in the Record of Decision.

27. Both the Department of the Interior and the State of Colorado submitted lists of editorial changes that should be made to the FS.

EPA Response. These corrections have been included in Appendix B of this Responsiveness Summary.

28. Alpenglow Excursions, ASARCO, Hecla, Leadville Corporation, and the State of Colorado questioned whether physical hazards to workers involved in implementing the proposed alternative had been fully addressed in the FS or sufficiently considered.

EPA Response. The physical hazards of rehabilitating the Yak Tunnel were taken into consideration during the detailed analysis of alternatives. Although the conditions within the tunnel may be poor, modern mining technology can be used to rehabilitate the tunnel safely. Nevertheless, in part because of concern about worker safety, the selected remedy minimizes the amount of work that will be necessary in the tunnel. All applicable health and safety requirements will be met.

29. Hecla commented that EPA failed to properly scope remedial or removal measures suitable to abate the threat and set priorities for implementation of the measures in accordance with 40 CFR Section 300.68(e)(1). Hecla also commented that EPA has not given appropriate review to a suite of alternatives.

EPA Response. Section 5 of the FS ("Scoping of Response Actions and Associated Technologies") describes how EPA determined the scope of response actions suitable to abate the threat from the Yak Tunnel. Sections 5, 6, 7, and 8 of the FS document the full range of alternatives considered by EPA and the reasons why they were rejected or retained. EPA has also set priorities for response action. EPA conducted a removal action to ensure that no families were using contaminated ground water for drinking water. In addition, EPA's preparation of an FS for the Yak Tunnel operable unit indicates EPA's priority for remedial action.

30. Hecla commented that EPA failed to address numerous factors relative to the effectiveness, feasibility, and cost-effectiveness of various technologies.

EPA Response. Hecla's comments did not identify the numerous factors, so EPA is not sure which factors were meant. Sections 7 and 8 of the FS describe the initial screening and detailed analysis of alternatives based on effectiveness, implementability, and cost.

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31. Hecla commented that EPA failed to evaluate the potential threat to human health and the environment associated with excavation, transport, and redisposal, or containment as required by 42 USC Section 9621(b)(1)(G).

    EPA Response. Several alternatives, including Alternatives 3 and 4, involved excavation, transport, and redisposal. The impacts from implementation of these alternatives are discussed under the screening analysis in Section 7. These alternatives were screened out during initial screening in part because of unacceptable environmental impacts. It was, therefore, unnecessary to complete a more detailed human health and environmental impact analyses.

    The selected remedy does not incorporate excavation, transport, and redisposal. Removal and disposal of the interim treatment plant sludge will be addressed in a subsequent operable unit. Tunnel plugging is fundamentally a containment remedy. EPA fully evaluated the impacts of tunnel plugging and developed a remedy that would mitigate potential impacts.

32. Numerous commenters, including ASARCO, Hecla, the State of Colorado, and Alpenglow Excursions, raised questions about the feasibility of rehabilitating the Yak Tunnel and the costs, safety considerations, and level of effort required to rehabilitate and maintain the tunnel.

    EPA Response. EPA agrees that rehabilitation and maintenance of the tunnel could be difficult, but believes that it is well within the scope of current technology and, provided it is carried out with experienced personnel, this work would be feasible and implementable. Nevertheless, the selected remedy minimizes the amount of tunnel rehabilitation that would be necessary.

33. Hecla commented that the stated goal of the FS provides no basis to determine which remedies, if any, cost-effectively attain such goals.

    EPA Response. The purpose of an FS is to evaluate alternative remedies. Part of the remedy selection process includes determining the degree of cleanup necessary to protect human health and the environment. The degree of cleanup is described in Section 4 and Appendix C of the FS. Alternatives were analyzed based on their attainment of these goals.

34. Hecla commented that the FS seemed to assume that the treatment facility would be located at the portal and

that other alternatives, such as location of the plant at the confluence of California Gulch and the Arkansas River, were not or were only superficially addressed.

EPA Response. Under alternatives considered in the FS, the treatment facility could be located near the confluence. The specific location was to be addressed during the design phase.

35. ASARCO stated that it was a relatively minor contributor to historical mining disturbances in California Gulch, including development and use of the Yak Tunnel, in the vicinity of the California Gulch site.

EPA Response. The relative contribution of particular parties to the contamination problem is not relevant to the selection of remedy.

36. ASARCO suggested that it is not only the sulfide rock that causes a water quality impact, but that oxidized mineral-bearing rock also can cause water quality problems.

EPA Response. EPA agrees with this comment but notes that the sulfide rock is a major source of contamination. It is anticipated that tunnel plugging will result in inundation of sulfide zones as well as some oxide and non-mineralized areas. Monitoring and contingency measures are incorporated into the selected remedy to deal with any water quality problems should they arise.

PUBLIC PARTICIPATION PROCESS

Hecla made numerous comments about responsible party and public participation in the remedy selection process. EPA also received comments during the public meeting about public participation. These are described below.

1. Hecla commented that it is entitled to raise all objections to the process of remedial action selection at the time when all components of a California Gulch remedy have been published. Hecla also stated that division of the response action into operable units restricts Hecla's constitutional and statutory rights to participate in the remedy selection process as a whole, rather than in ad hoc segments.

restricts Hecla's constitutional and statutory rights to participate in the remedy selection process as a whole, rather than in ad hoc segments.

EPA Response. EPA disagrees with this comment. Under Section 300.68(c) of the NCP, response actions may be conducted in operable units. As discussed above, EPA selected the operable unit remedy in accordance with the CERCLA, SARA, and the NCP. As described in Section IV of the Record of Decision, EPA complied with all statutory and regulatory provisions regarding public participation in the remedy selection process.

2. Hecla stated that the RI/FS process is not a true administrative proceeding, is ad hoc, and is unrelated to rulemaking. Hecla also stated that the process is not committed to a single administrative agency, but requires the contribution of several state and federal agencies.

EPA Response. The process for selection of remedial actions is described in the NCP (40 CFR Section 300.68). Under the NCP, the lead agency conducting the remedial action shall, as appropriate, undertake an RI/FS and select a remedy [40 CFR Section 300.68(d)(i)]. EPA is the lead agency for the California Gulch site. As part of the remedy selection process, EPA must consult with the State of Colorado. See 42 USC Section 9621(d)(2) (A)(ii),(f). To identify and ensure compliance with ARARs, EPA also has consulted with various federal agencies. Along with the public, federal agencies were given an opportunity to comment on the FS and proposed remedial action plan.

3. Hecla asserted that the RI/FS process is subject to supervision of the federal court and compliance with the Federal Rules of Civil Procedure. Hecla also stated that remedy selection is a matter for judicial rather than administrative determination.

EPA Response. EPA has the authority to undertake response actions and order responsible parties to undertake response actions without supervision of a federal court or compliance with the Federal Rules of Civil Procedure (see 42 USC Sections 9604 and 9606). EPA may also seek judicial relief as may be necessary to abate threats to public health or welfare or the environment under 42 USC Section 9606. In this instance, EPA has filed an action seeking to have responsible parties implement the remedy selected by EPA. Under 42 USC Section 9613(j), judicial review of any issues concerning the adequacy of any response action taken or ordered by EPA is limited to the administrative record.

4. Hecla commented that the RI/FS process is constitutionally defective because EPA has not provided defendants with a meaningful opportunity for comment and input into the process such that due process requisites could be satisfied. Hecla protested EPA's unauthorized actions and claimed that the comment period was a nullity and that any decision based on the self-serving, one-sided FS and proposed remedial action plan would be arbitrary, capricious, in excess of EPA's jurisdiction, and unauthorized by law.

   EPA Response. EPA disagrees with this comment. As noted above, EPA has conducted the remedy selection process in accordance with all statutory and regulatory requirements. Various defendants in United States v. Apache and Energy Minerals Co., including Hecla, were given the opportunity to play a substantial role in the remedy selection process. Some of these opportunities are described in Section IV of the Record of Decision and Appendix A of this Responsiveness Summary. EPA has carefully considered comments, information, and proposals received from defendants and other members of the public. The Record of Decision and this Responsiveness Summary document how these comments have been incorporated or addressed.

5. Hecla asserted that the RI/FS documents are nothing more than summaries of expected testimony of expert witnesses.

   EPA Response. EPA disagrees with this comment. Under 40 CFR Section 300.68, EPA conducts an RI/FS to determine the nature and extent of the threat presented by the release and to evaluate proposed remedies. The RI/FS documents are part of the administrative record for judicial review.

6. Hecla commented that the conflicting role of EPA and the State of Colorado led to duplications and inconsistencies.

   EPA Response. EPA developed and selected the remedy for the Yak Tunnel operable unit in consultation with the State of Colorado. Studies completed by the State are part of the administrative record upon which EPA based selection of the remedy.

7. Hecla commented that EPA's analysis of the California Gulch site has so confused the nature of contamination, its sources, the relationship of the Yak Tunnel to the rest of the site, and the sequence of reports and studies that it is impossible for the type of detailed and systematic consideration of environmental, economic,

and institutional issues and impacts as mandated in both CERCLA and the National Environmental Policy Act.

EPA Response. The Executive Summaries of the Phase I RI and the FS briefly describe the sources and nature of site contamination. The introductions to both the documents also describe the Superfund remedy selection process for the California Gulch site and how the various documents relate to this process. The FS describes the Yak Tunnel and the function of the operable unit. The FS includes detailed analyses of alternatives as required by the NCP.

8. Hecla commented that EPA has foreclosed interested parties from any meaningful opportunity to provide reasonable comment and information regarding potential remedies. Specifically, Hecla noted that EPA has made no determination that good faith negotiations with responsible parties are not or were not possible as required by Section 122 of CERCLA and further stated that this systematic exclusion of parties from the remedy selection process has deprived EPA of potentially valuable insight and experience. Hecla also asserted that EPA's failure to take a constructive role in site remediation, including entry into agreements with responsible parties, has created a long and complex lawsuit and indicates a complete disregard for the mandates of CERCLA.

   EPA Response. In accordance with guidance applicable at the time, EPA sent notice letters in 1983 to potentially responsible parties to give them the opportunity to perform the RI/FS for the California Gulch site. All declined to do so. Nevertheless, throughout EPA's conduct of the RI/FS, interested parties reviewed information and submitted proposed remedies to EPA. EPA has held numerous meetings with interested parties, including defendants, to obtain information about the site and to hear the views of various parties. EPA has carefully considered these comments and incorporated various aspects of proposed remedies into the selected remedy. EPA plans to enter into formal settlement discussions under Section 122 for responsible party performance of the selected remedy.

9. Hecla stated that the timing of release and the comment periods on the Phase I RI, the FS, and the proposed remedial action plan stymied responsible party cooperation in the best possible remedy. Specifically, Hecla noted that the FS and proposed remedial action plan were released during the comment period on the Phase I RI and that EPA provided only a few weeks for public review.

EPA Response. Even though a public comment period is not required by CERCLA or the NCP, EPA held a 30-day comment period on the Phase I RI. Comments were due July 12, 1987. EPA granted all requests for extensions of time to comment on the RI. The FS was released to defendants for comment on July 6, 1987. The NCP requires a 21-day comment period on FSs. However, EPA held a 90-day comment period on the Yak Tunnel FS. EPA believes that defendants had ample opportunity to comment meaningfully. Indeed, the comments of one defendant were nearly as long as the FS itself.

10. Hecla commented that EPA ignored substantive public comments at the September 1, 1987, public meeting in development of its preferred alternative.

    EPA Response. The proposed remedial action plan, which identified EPA's preferred alternative, was released in August 1987, prior to the public meeting on September 1.

11. During the public meeting, the Collegiate Peaks Chapter of Trout Unlimited suggested that copies of the FS should be sent to the libraries in Buena Vista, Salida, Canon City, and Pueblo.

    EPA Response. EPA sent copies of the FS to the libraries in those cities and added the suggested recipients' addresses to the California Gulch mailing list so future documents would be sent there as well.

12. The Collegiate Peaks Anglers expressed disappointment that the availability of the proposed remedial action plans sent to the Buena Vista, Salida, Canon City, and Pueblo libraries was not publicized. This group believes that the public would have had more input if EPA had issued public notices in these communities.

    EPA Response. EPA will endeavor to provide additional notice to these communities in the future.

OTHER COMMENTS

1. The Department of the Interior commented that consideration must be given to the impacts on mineral resources remaining in the Leadville Mining District. The Department cited Bureau of Mines information that deposits of gold, silver, copper, lead, and zinc remain in the Leadville workings. Leadville Mining and Milling Corporation also expressed concern for the future workings of the company as well as Leadville Corporation and Highland Consolidated Mining Corporation should the water levels within these other mines rise due to the plugging of Yak Tunnel.

EPA Response. Plugging of any or all portions of the Yak Tunnel will not halt recovery of remaining mineral resources. However, present or future operators may need to dewater their facilities. For example, the proposal of Leadville Corporation discussed above includes installation of a tunnel plug, dewatering of the mine workings, and treatment and discharge to Big Evans Gulch.

2. Leadville Corporation asserted that water draining from the Leadville Corporation's property into the Yak Tunnel is clean and that it has a value that should not be wasted.

   EPA Response. EPA has reviewed data provided by Leadville Corporation regarding water quality in the vicinity of the Resurrection workings, but has not collected its own data nor independently verified the data provided. The selected remedy is not expected to affect whatever value this water may have as a resource.

3. ASARCO presented a site history in its response to the FS, including a history of the Leadville Mining District and the Yak Tunnel.

   EPA Response. EPA has reviewed the information and included ASARCO's comments in the administrative record. In addition, EPA incorporated certain elements into the "Site History" section of the Record of Decision.

4. Mr. Don Seppi of Leadville asked what the schedule is for EPA's implementation of the Yak Tunnel remedy.

   EPA Response. The schedule for implementation of the Yak Tunnel selected remedy is presented in the Record of Decision.

5. ASARCO, Hecla, and others made numerous comments on legal and technical matters.

   EPA Response. In this Responsiveness Summary, EPA separately identified and responded to significant comments, criticisms, and new data presented during the public comment period. EPA does not necessarily agree with any comment, criticism, or information submitted for which a specific response was not prepared.

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IV. EXPLANATION OF DIFFERENCES BETWEEN THE PROPOSED PLAN AND THE SELECTED REMEDY

EPA identified Alternative 5 as the preferred alternative in the proposed remedial action plan for the Yak Tunnel operable unit. The key elements of this alternative were:

1. Rehabilitation of the tunnel to reduce the probability of surge events and to ensure the continued collection of contaminated water;
2. Diversion of surface water in upper California Gulch to reduce infiltration to a portion of the Yak Tunnel;
3. Surge protection and short-term treatment ponds to minimize the effects of sludge and water surges that could occur when the tunnel is entered for ongoing field investigations and rehabilitation, and to regulate flow to the treatment plant;
4. A physical treatment plant incorporating a neutralization-precipitation process; and
5. A structure to convey treated water to the lower reaches of California Gulch or the Arkansas River.

EPA also recognized that Alternative 7 in the FS, which includes partial plugging of the Yak Tunnel, had the potential to decrease the contaminant mass loads and the quantity of water to be treated. Therefore, EPA retained the possibility of incorporating a plugging component into the remedy at a future date.

As discussed previously, EPA received extensive comment on the proposed plan and has modified the remedy to address major concerns about tunnel rehabilitation and maintenance and perpetual operation of the treatment system. The selected remedy is a logical outgrowth of the remedy identified in the proposed plan and other alternatives developed and evaluated in the FS. The components of the selected remedy were conceptually evaluated in the FS and the selected combination of actions was well within the range of alternatives the public could have reasonably anticipated EPA to be considering.

The primary difference between Alternative 5 and the selected remedy is the inclusion of a tunnel plugging component in the selected remedy. In the proposed plan, EPA retained the possibility of partial plugging, but identified four concerns about potential effects of plugging. These were concerns about (1) predicting the effects of tunnel plugging based on the limited data available about mine workings and hydrogeological conditions, (2) the influence of dewatering activities in the Black Cloud Mine, (3) risks of contaminating the Leadville water supply through migration of contaminated water towards Big Evans Gulch, and (4) effects on future mineral resource development in the area.

Because of issues raised and information provided during the public comment period, EPA re-evaluated its concerns about tunnel plugging. EPA determined that concerns about ground water movement, Black Cloud operations, and the Leadville water supply could be adequately addressed through water control measures, a pump and treatment system, a comprehensive monitoring program, and contingency plans. In addition, EPA determined that tunnel plugging would not restrict future resource development as water could be pumped from mine workings and treated.

V. REMAINING CONCERNS

OPERABLE UNITS

As discussed previously, EPA anticipates conducting response actions for the California Gulch Superfund site in operable units. An operable unit is defined in the NCP as "a discrete part of the entire response action that decreases a release, threat of release, or pathway of exposure." Implementation of operable units may begin before selection of a final remedial action for the site if the operable units are cost-effective and consistent with a permanent remedy.

EPA plans three operable units for the California Gulch site: the Yak Tunnel operable unit, an operable unit addressing mine wastes and ephemeral drainages, and the overall site remedy. An RI/FS has been or will be prepared for each operable unit.

Remedy selection for the Yak Tunnel operable unit has been completed. The attached Record of Decision documents EPA's decision to plug the tunnel to reduce metals loading on California Gulch and the Arkansas River. This decision was based on the Phase I RI and the Yak Tunnel Operable Unit FS. The second operable unit will cover mine waste east of the Town of Leadville, excluding the slag piles, and ephemeral drainages. Preparation of a Phase II RI is now under way. The third operable unit will address overall site remediation. This will be initiated after completion of the necessary studies required to characterize the nature and extent of contamination for the remaining portion of the California Gulch Site. Generally, this includes investigation of air, radiation, and organic contamination. In addition, additional characterization of soil, sediments, and surface and ground water will be done. EPA is now preparing the scope of work for the Phase II RI/FS.

ENDANGERMENT ASSESSMENT

A Preliminary Endangerment Assessment (PEA), using the data compiled during the Phase I and Phase II RI of the California Gulch site, will be prepared to characterize the nature and extent of threats to public health and welfare and the environment. The PEA will be prepared pursuant to all applicable EPA guidance and will be based on all available data. The PEA will lead to the identification of data gaps that need to be filled by Phase III RI sampling.

A complete Endangerment Assessment (EA) that summarizes the contaminants of concern, the possible pathways of exposure, and the threats to public health or welfare or the environment posed at the California Gulch site will be developed following the Phase III RI. Much of the data required to perform the complete EA will be collected during Phase III activities; however, additional data, including all studies conducted at the site and all the data obtained during the Phase I and Phase II RI will also be used.

Appendix A

LIST OF COMMUNITY RELATIONS ACTIVITIES

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LIST OF COMMUNITY RELATIONS ACTIVITIES

- Onsite interview for Community Relations Plan (October 1985)
- Fact Sheet on Superfund process (January 1985)
- First public meeting on RI/FS process (February 7, 1985)
- Draft Community Relations Plan Update (November 19, 1985)
- Public meeting on RI/FS status (December 3, 1985)
- Fact Sheet on status of RI activities (April 1986)
- Public meeting to update status of RI/FS process (April 7, 1986)
- Fact Sheet on Yak Tunnel remedial alternatives (June 1987)
- Public comment period on Phase I RI Report (June 9 through July 12, 1987) (provided extensions for comment upon request)
- Letters to defendants enclosing copy of Phase I RI Report and notifying them of opportunity to comment (June 9, 1987)
- Letters to defendents enclosing copy of Yak Tunnel FS Report and notifying them of opportunity to comment (July 6, 1987)
- Public comment period on Yak Tunnel FS Report (July 7 through October 5, 1987)
- Press release on opportunity to comment on Yak Tunnel FS Report (July 7, 1987)
- Fact Sheet mailed to over 100 people on Yak Tunnel remedial alternatives (July 1987)
- Letters to defendants notifying them of extension of comment period on Yak Tunnel FS Report (August 7, 1987)
- Press release on availability of Proposed Remedial Action Plan for Yak Tunnel (August 17, 1987)

- Letters to defendants enclosing copy of Proposed Remedial Action plan for the Yak Tunnel Operable Unit and notifying them of opportunity to comment (August 19, 1987)
- Full-page notice in Leadville Herald Democrat on brief analysis of plan and alternative plans (August 20, 1987)
- Copies of proposed plan for Yak Tunnel mailed to complete mailing list and information centers (July 1987)
- Copies of Administrative Record to information centers (September 15, 1987)
- Letters to defendants notifying them of the availability and location of the interim administrative record for the California Gulch site (September 24, 1987)
- Press release (August 25, 1987) and articles on location and availability of administrative record published in Leadville Herald Democrat (October 1, 1987), and Rocky Mountain News (October 2, 1987)
- Public meeting on the Yak Tunnel FS Report (September 1, 1987)
- Copies of September 1, 1987 public meeting transcripts to all commenters at the public meeting and to information centers (February 1988)

ONGOING ACTIVITIES

- Meetings with Lake County Commissioners
- Meetings with Leadville City Council
- Responses to requests for information
- Responses to questions about site activities and the Superfund process
- Meetings with concerned citizens and potentially responsible parties
- Information centers with technical information, studies, and, in Leadville, pleadings from U.S. v. Apache Energy and Minerals Co.

Appendix B
YAK TUNNEL FEASIBILITY STUDY REVISIONS
CALIFORNIA GULCH SITE

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YAK TUNNEL FEASIBILITY STUDY REVISIONS
CALIFORNIA GULCH SITE

Page	Line	Correction
vii	2	Title for Table 1 should be "Comparison of Compounds and Criteria"
x	23	"Ferrooxidans" should be "iron-oxidizing bacteria"
xviii,	Col. 2, ¶2, L3	"(ion change)" should read "(ion exchange)"
xviii,	Col. 3 ¶2, L11	To the sentence that ends "effectiveness of the plug...", add "and its impacts on the groundwater system and other mine drainage tunnels, such as the Leadville Mine Drainage Tunnel."
xviii	Col. 3 ¶6	"because a similar treatment plant" should read, "a similar treatment plant"
xix	10	Replace "deformation" with "stress"
xx	17-18	End sentence after "2 min."
xxi	18	"electronics" should be replaced with "electrons"
xxxii	3	Insert title for Table 1; "Comparison of compounds and Criteria"
2-7	14-18	"Iron (960 to 15,500 mg/kg)" shoud read "Iron (9,600 to 15,500 mg/kg)"; "aluminum (1,920 to 14,000 mg/kg)" should read "aluminum (1,920 to 140,000 mg/kg)"
2-10	Fig 2-3	Tennessee Creek should have been labeled.
2-12	16-24	Add a sentence stating that "Additional studies are underway which will enhance our understanding of metal loadings in the Arkansas River."
2-13	Fig 2-4	Add a note that the percent of contribution from these sources vary seasonally.

Appendix B
(continued)

Page	Line	Correction
2-15	30	"at the end" should read "at the beginning"
3-2	13-23	The Department of the Interior noted that a third study report was completed. Although never formally published, a copy has been given to the EPA by the Bureau of Reclamation.
3-22	1	Replace "by bioaccumulation" with "for bioaccumulation"
3-22	2	"(pages 3-2 to 3-3)" should be inserted after "as previously summarized"
4-12	Table 4-2	A revised table is attached.
7-11	13	Reference to "Table 7-2" should read "Figure 7-2"
7-12	Fig 7-1	Discharge from Yak Tunnel to California Gulch should be "5" and total flow in the gulch should be "135."
8-12	Cols 4 and 5	First entries should be switched.
8-32	Table 8-7	Headings should be fixed so that second HDS column falls under Alternative 7
8-40	5	"$123.9 million" should read "$23.9 million"
8-41	5	Insert "and to ensure there are no adverse impacts to facilities such as the Leadville Mine Drainage Tunnel." after "effectiveness of the plug."

Revised Table 4-2
CONTAMINANT-SPECIFIC DEGREE OF CLEANUP CRITERIA

	Drinking Water		Aquatic Life Water Quality Criteria[a] (µg/l)	
	MCL[b] (mg/l)	MCLG[c] (mg/l)	Acute	Chronic
Arsenic	0.050	0.050	360	190
Barium	1.0	1.5	--	--
Cadmium	0.010	0.005	3.9(+)	1.1 (+)
Chromium (total)	--	0.12	--	--
+6	0.05	--	16	11
+3	--	--	1,700	210
Copper	1.0[d]	1.3	18	12(+)
Iron	0.3[d]	--	--	1,000
Lead	0.050	0.020	82	3.2(+)
Manganese	0.05	--	--	--
Mercury	0.002	0.003	2.4	0.012
Nickel	--	--	1,400(+)	160(+)
Selenium	0.01	0.045	20	5.0
Silver	0.050	--	4.1(+)	
Zinc	5.0	--	120	110

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[a] Clean Water Act; 40 CFR part 131, for protection of aquatic life. EPA, Quality Criteria for Water 1986 (May 1986); Hardness dependent criteria listed at hardness = 100 mg/l $CaCO_3$. EPA, Ambient Water Quality Criteria for Nickel--1986 (September 1986). EPA, Ambient Water Quality Criteria for Zinc--1987 (March 1987), EPA, Ambient Water Quality Criteria for Selenium--1987 (September 1987).

[b] Safe Drinking Water Act, 40 CFR Part 141, Subpart B.

[c] Safe Drinking Water Act, Federal Register, Vol. 50, No. 219, November 13, 1985, p. 47022.

[d] Secondary MCLs.

Note: Hardness dependent; 100 mg/l $CaCO_3$ equivalents value listed.